

**TRANSMITTAL LETTER TO THE UNITED STATES  
DESIGNATED/ELECTED OFFICE (DO/EO/US)  
CONCERNING A FILING UNDER 35 U.S.C. 371**INTERNATIONAL APPLICATION NO.  
**PCT/JP00/00629**INTERNATIONAL FILING DATE  
**4 February 2000**(EARLIEST) PRIORITY DATE CLAIMED  
**5 February 1999**

TITLE OF INVENTION

**ENCODING SYSTEM AND METHOD, DECODING SYSTEM AND  
METHOD, MULTIPLEXING APPARATUS AND METHOD, AND  
DISPLAY SYSTEM AND METHOD**

APPLICANTS FOR DO/EO/US

**Katsumi TAHARA and Yoshihiro MURAKAMI**

Applicants herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
  - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☒ has been transmitted by the International Bureau.
  - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)), including **26** sheets of formal drawings and a copy of the International Search Report.
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
  - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☐ have been transmitted by the International Bureau.
  - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
  - d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventors (35 U.S.C. 371(c)(4)).
10. ☐ The annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

**Items 11. to 16. below concern other document(s) or information included:**

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.  
☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information:

PCT/ISA/210, 220, PCT/IB/301, 304 and 308

PCT/RO/101

References for IDS

**EXPRESS MAIL**Mailing Label Number: **EL588273800US**Date of Deposit: **October 3, 2000**

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"Express Mail Post Office to Addressee" Service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents and Trademarks, Box PCT Washington, DC 20231.

*Charles J. Sutton*  
(Typed or printed name of person mailing paper or fee)*Charles J. Sutton*  
(Signature of person mailing paper or fee)

U S APPLICATION NO (If known, see 37 C.F.R. 1.50)

INTERNATIONAL APPLICATION NO.

ATTORNEY'S DOCKET NO

09/647620

PCT/JP00/00629

450108-02465

17. ☒ The following fees are submitted:

(CALCULATIONS /PTO USE ONLY)

**Basic National Fee (37 CFR 1.492(a)(1)-(5):**

Neither international preliminary examination fee (37 CFR 1.482) nor  
international search fee (37 CFR 1.445(a)(2)) paid to USPTO and  
International Search Report not prepared by the EPO or JPO... \$1000.00

International preliminary examination fee (37 C.F.R. 1.482)  
not paid to USPTO but International Search Report prepared  
by the EPO or JPO.....\$ 860.00

International preliminary examination fee paid to USPTO (37 CFR 1.482)  
Not paid to USPTO but international search fee (37 CFR 1.445(a)(2))  
paid to USPTO (37 CFR 1.445(a)(2)).....\$ 710.00

International preliminary examination fee paid to USPTO (37 CFR 1.482)  
But all claims did not satisfy provisions of PCT Article 33(1)-(4).....\$ 690.00

International preliminary examination fee paid to USPTO (37 CFR 1.482)  
and all claims satisfied provisions of PCT Article 33(1)-(4).....\$ 100.00

ENTER APPROPRIATE BASIC FEE AMOUNT = (\$860.00)

Surcharge of \$130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 (\$ /  
months from the earliest claimed priority date (37 CFR 1.492(e)).

29 Claims /Number Filed / Number Extra /Rate (

Total Claims / 29 - 20 = / 9 /X \$18.00 (\$ 162.00

Independent Claims / 20 - 3 = / 17 /X \$80.00 (\$ 1,360.00

Multiple dependent claim(s) (if applicable) /+ \$260.00 (\$

**TOTAL OF ABOVE CALCULATIONS = (\$ 2,382.00**

Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity (  
statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28). ( /

**SUBTOTAL = (\$ 2,382.00**

Processing fee of \$130.00 for furnishing the English translation later than ( /  
☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).+ (\$ /

**TOTAL NATIONAL FEE = (\$ 2,382.00**

Fee for recording the enclosed assignments (37 CFR 1.21(h)). The assignment (\$ 40.00/  
must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) \$40.00 per property + (\$ /

**TOTAL FEES ENCLOSED = (\$ 2,422.00**

(Amount to be: /  
(refunded) /\$  
(charged) /\$

- a. ☒ Our checks in the amount of **\$2,422.00** to cover the above fees are enclosed.  
b. ☐ Please charge my Deposit Account No. 50-0320 in the amount of \$\_\_\_\_\_ to cover the above fees.  
A duplicate copy of this sheet is enclosed.  
c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 50-0320. A duplicate copy of this sheet is enclosed.  
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

**WILLIAM S. FROMMER**  
**FROMMER LAWRENCE & HAUG LLP**  
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SIGNATURE

**WILLIAM S. FROMMER**  
NAME

Dated: October 3, 2000

25,506  
REGISTRATION NUMBER

09/647620 02924350

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant(s) : TAHARA et al.  
Corresponding Int'l Appln. No. : PCT/JP00/00629  
International Filing Date : 4 February 2000  
Priority Dates Claimed : 5 February 1999  
For : **ENCODING SYSTEM AND METHOD,  
DECODING SYSTEM AND METHOD,  
MULTIPLEXING APPARATUS AND  
METHOD, AND DISPLAY SYSTEM AND  
METHOD**

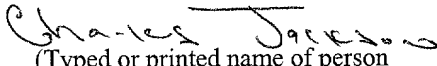
745 Fifth Avenue  
New York, NY 10151

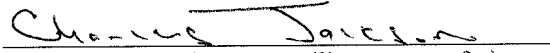
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Mailing Label Number: EL588273800US

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**PRELIMINARY AMENDMENT**

Assistant Commissioner for Patents  
Box PCT  
Washington, D.C. 20231

Dear Sir:

Prior to the issuance of the first Office Action, please amend the above-identified application as follows:

09/647620

**IN THE SPECIFICATIONS:**

Page 8, delete line 8-12;

Page 11, line 18, please delete "cerding" and insert --coding--;

Page 20, line 8, please delete "F2" and insert --F3--;

Page 20, line 21, please delete "27 (=128)" and insert --2<sup>7</sup> (= 128)--;

Page 21, Line 15, please delete "the 2:3 pull-down circuit 7" and insert --the 2:3

pull-down circuit 103--;

Page 37, line 5, please delete "Time code ()" and insert --Time\_code ()--.

**IN THE CLAIMS:**

Cancel claim 13;

Claim 22, line 8, please delete "said packetizer" and insert --packetized elementary stream--.

**REMARKS**

The changes to the specification correct typographical errors. The amendment to claim 22 corrects an obvious error.

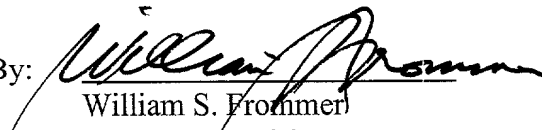
An early examination on the merits is earnestly solicited.

Please charge any additional fees required for this amendment or credit any overpayment to Deposit Account No. 50-0320.

Respectfully submitted,

FROMMER LAWRENCE & HAUG LLP

By:



William S. Frommer

Reg. No. 25,506

(212) 588-0800

## DESCRIPTION

Encoding System and Method, Decoding System and Method, Multiplexing Apparatus and Method, and Display System and Method

## Technical Field

The present invention relates to an encoding system for encoding input video data and a decoding system for decoding encoded streams.

## Background Art

Recently, in order to compress/encode video data, the MPEG (Moving Picture Experts Group) technology standardized as ISO/IEC 13818 has come into common use at broadcasting stations that produce and broadcast television programs. MPEG is becoming the de facto standard especially for recording video data generated by video cameras or the like, on tape, disks, or other recording media that can be accessed randomly or for transmitting video programs produced at broadcasting stations, via cables or satellites.

The MPEG technology is an encoding technology that can improve compression efficiency by means of predictive coding of pictures. More particularly, the MPEG standard employs a plurality of predictive coding systems that combine intra-frame prediction and inter-frame prediction, and each picture is encoded by means of either of the following picture types: I-picture (Intra Picture), P-picture (Predictive Picture), and B-picture (Bidirectionally Predictive

Picture) according to the prediction system. The I-picture, which is not predicted from other pictures, is a picture encoded within the frame. The P-picture is a picture subjected to inter-frame forward predictive coding by a preceding (past) I-picture or P-picture. The B-picture is a picture subjected to bidirectionally predictive coding both by a preceding (past) I-picture or P-picture and by a following (future) I-picture or P-picture.

A multiplexing system for multiplexing a plurality of video programs produced at broadcasting stations will be described first with reference to Figure 1.

The MPEG encoders 11 to 19 create encoded streams by encoding received source video programs V1 to V9, respectively, according to the MPEG standard described above. Such encoded streams are also known as elementary streams.

The packetizers 21 to 29 receive the elementary streams output from the MPEG encoders 11 to 19, respectively, and packetize them to create packetized elementary streams (PES). The packetizer process will be described in detail later.

Each of the transport stream generation circuits (TS Gen) 31 to 39 creates a transport stream consisting of 188-byte transport stream packets from the packetized elementary streams output from the respective packetizers 21 to 29.

The system target decoder buffers (STD buffers) 41 to 44 receive and buffer the transport streams output from the transport stream generation circuits. The STD buffers, which are fixed-capacity buffers

specified by the MPEG standard, are provided for the purpose of simulation to prevent receive buffer from overflowing and underflowing on the MPEG decoder side.

The multiplexing circuit 40 receives a transport stream from each of the system target decoder buffers 41 to 44 and multiplexes the transport streams according to schedule.

Now the packetization by the packetizers 21 to 29 of the multiplexing system described in Figure 1 as well as the delays produced during the packetization will be described in detail with reference to Figure 2.

Figure 2A shows the order of pictures in source video data supplied to the MPEG encoders. This is a typical example in which source video data is encoded as a GOP structure in the form of I, B, B, P, B, B, P, and so on.

Figure 2B shows the order of pictures in an encoded stream (elementary stream) encoded by an MPEG encoder. Since B-pictures B2 and B3 are predictive-coded from both I-picture I1 and P-picture P4 as described above, the order of pictures in the encoded stream is I, P, B, B, P, B, B, P, and so on.

Figure 2C shows a packetized elementary stream (PES) generated by a packetizer. Since a packetizer is the circuit that packetizes the encoded streams output from an encoder and adds a PES header to the packets, the order of pictures in the packetized elementary stream is the same as the order of pictures in the encoded stream output from the encoder.

The packetization carried out by packetizers does not take much time. As can be seen by comparing Figure 2B and Figure 2C, however, the packetized elementary stream lags behind the elementary stream by four frames. The reason for this delay will be described in detail below.

The MPEG standard described above defines the decoding timing of each picture for an MPEG decoder by the data called a decoding time stamp (DTS), and the display timing of decoded video data by the data called a presentation time stamp (PTS). Therefore, MPEG decoders must decode each picture in an encoded stream with the timing based on the DTS and output the decoded video data with the timing based on the PTS.

To enable such decoding, the MPEG standard requires the PTS and DTS to be specified for each picture when encoded streams are transmitted or multiplexed. Furthermore, the MPEG standard provides that the PTS and DTS information should be described in the PES header. In other words, the packetizer that generates packetized elementary streams must generate the PTS and DTS.

Now the determination of the PTS by the packetizer after the packetizer receives the elementary stream shown in Figure 2B from an MPEG encoder will be described.

It is easy to determine a PTS for picture I1 received first because it is an I-picture, which is to be presented first. Let's assume that it is assigned a PTS of "1."

The second picture received is a P-picture, P4. As can be seen from the order of pictures in the source video shown in Figure 2A,



P-picture P4 must be displayed after a plurality of B-pictures that follow it. At the time (t5) when the packetizer receives picture P4, however, it does not know how many B-pictures will be transmitted successively after picture P4. Therefore, it is not possible to determine the PTS of picture P4 at the time (t5) when it is received. Thus, the packetizer buffers the first picture I1 and second picture P4. This buffering must be continued until the PTS of picture P4 is determined.

The third and fourth pictures, B2 and B3, are B-pictures, so their PTSs can be determined immediately. That is, the PTS of picture B2 is "2" and the PTS of picture B3 is "3."

The fifth picture, P7, is a P-picture. Only after receiving this P-picture (at t8), the packetizer knows that the second picture, P4, was followed by two successive B-pictures, and can assign the PTS of "4" to picture P4 after receiving P-picture P7 (at t8). In other words, only after receiving P-picture P7 (at t8), the packetizer knows that the GOP structure (I, P, B, B, P, and so on) of the elementary stream consists of two B-pictures sandwiched between an I-picture and P-pictures, and can decide the PTSs for all the pictures.

In order to determine PTSs as described above, the packetizer must buffer the elementary stream received at t4 until t8. In other words, there is a delay of four frames in the process of determining PTSs.

In case of a GOP structure with two B-pictures between an I-picture and P-pictures as shown in FIG 2, there is a four-frame delay as described above. In case of a GOP structure with four B-pictures between an

I-picture and P-pictures, there is a six-frame delay. Thus, if the number of B-pictures existing between an I-picture and P-pictures is denoted as N, there is a delay of  $(N + 2)$  frames in the PTS determination process.

Besides, there are also problems in designing packetizers. For example, to produce a delay of four frames, four frame buffer memories are sufficient. However, since streams with various GOP structures may be supplied to packetizers as shown in Figure 1, the number of frame memories must be designed assuming the maximum number of B-pictures that can exist between an I-picture and P-pictures so that any encoded stream of any GOP structure can be accommodated. As an example, if the maximum number of B-pictures is assumed to be "5" as a reasonable number, a multiplexing system for multiplexing nine video programs needs nine packetizers as shown in Figure 1. This means that a total of 45 frame memories must be provided. Consequently, the problem with implementing such a multiplexing system is the high cost of equipment.

Furthermore, as shown in Figure 3, the transmission of the video data prepared at a reporting site to individual households involves transmission from the reporting site to the main broadcasting station, transmission within the main broadcasting station, transmission from the main broadcasting station to local stations, transmission from the local stations to the households, etc. All these transmission processes involve generating packetized elementary streams. Consequently, delays are produced in the generation of the packetized

elementary streams in the individual transmission processes and accumulated into a large delay.

#### Disclosure of the Invention

The present invention relates to an encoding system for encoding input video data and a multiplexing system for multiplexing a plurality of encoded streams. More particularly, it proposes encoding and decoding systems for packetizing encoded streams without delay.

It proposes a system and method that involve describing, in encoded streams, information on the picture order of input video data and using the picture order information when generating packetized elementary stream (PES) packets to prevent delays associated with the PES packet generation.

The MPEG encoder generates PTS\_count and DTS\_count based on the information obtained from the number of fields in the input video data and describes the PTS\_count and DTS\_count data as picture order information in encoded streams. The packetizer that generates packetized elementary streams takes out PTS\_count and DTS\_count described in the encoded streams, generates presentation time stamps and decoding time stamps based on PTS\_count and DTS\_count, and adds them as PES header data.

An encoding system for encoding input video data generates an elementary stream by encoding input video data, describes in the elementary stream its picture order information, receives the elementary stream, and generates time stamp information about the

elementary stream based on the picture order information described in the elementary stream.

An encoding system for encoding input video data generates an elementary stream by encoding input video data, describes in the elementary stream its picture order information, and packetizes the elementary stream based on the picture order information described in the elementary stream.

An encoding system for encoding input video data generates an elementary stream by encoding input video data, describes in the elementary stream its picture order information, and packetizes the elementary stream based on the picture order information described in the elementary stream.

An encoding system for encoding input video data generates an elementary stream by encoding input video data, multiplexes, in the elementary stream, time stamp information about the decoding and/or presentation of the elementary stream, receives the elementary stream, and performs stream processing for the elementary stream based on the time stamp information described in the elementary stream.

An encoding system for encoding a plurality of input video data generates a plurality of elementary streams by encoding the plurality of input video data, describes, in each of the elementary streams, time stamp information about the decoding and/or presentation of the elementary streams, receives the plurality of elementary streams, and multiplexes the plurality of elementary streams based on the time stamp information added in each elementary stream.

An encoding system for encoding input video data encodes the input video data to generate an elementary stream, generates a packetized elementary stream from the elementary stream, and describes, in the elementary stream, the information needed to generate the time stamp to be described in the header of the packetized elementary stream.

A multiplexing apparatus for multiplexing the plurality of elementary streams generated by encoding a plurality of input video data comprises means for extracting the time stamp information associated with each of the plurality of elementary streams from the plurality of elementary streams and means for multiplexing the plurality of elementary streams based on the time stamp information extracted from each elementary stream.

A decoding system for decoding the encoded stream generated by encoding source video data extracts the decoding time stamps contained in the encoded stream and decodes the encoded stream based on the decoding time stamps, which are information generated based on the number of fields in the source video data.

A display system for generating decoded video data by decoding the encoded stream generated by encoding source video data and for displaying the decoded video data extracts the presentation time stamp contained in the encoded stream, decodes the encoded stream to generate decoded video data, and displays the decoded video data based on the presentation time stamps, which are information generated based on the number of fields in the source video data.

## Brief Description of Drawings

Figure 1 is a block diagram showing the configuration of the multiplexing system in a system that comprises a conventional MPEG encoder and decoder.

Figure 2 is a schematic diagram showing the structure of each GOP.

Figure 3 is a schematic block diagram showing the flow of video data.

Figure 4 is a block diagram showing the configuration of the encoding/decoding system according to the present invention.

Figure 5 is a schematic diagram showing an elementary stream and transport stream.

Figure 6 is a block diagram showing the configuration of an MPEG encoder.

Figure 7 is a schematic diagram illustrating a 3:2 pull-down process.

Figure 8 is a schematic diagram showing the full pixel area and active video area of video data.

Figure 9 is a schematic diagram showing the structure of each frame.

Figure 10 is a schematic diagram showing the syntax of a video sequence.

Figure 11 is a schematic diagram showing the syntax of a sequence header.

Figure 12 is a schematic diagram showing the syntax of a sequence extension.

Figure 13 is a schematic diagram showing the syntax of extension and user data.

Figure 14 is a schematic diagram showing the syntax of user data.

Figure 15 is a schematic diagram showing the syntax of a data ID.

Figure 16 is a schematic diagram showing the syntax of V-Phase.

Figure 17 is a schematic diagram showing the syntax of H-Phase.

Figure 18 is a schematic diagram showing the syntax of a time code.

Figure 19 is a schematic diagram showing the syntax of a time code.

Figure 20 is a schematic diagram showing the syntax of a picture order.

Figure 21 is a schematic diagram showing the syntax of ancillary data.

Figure 22 is a schematic diagram showing the syntax of a group of picture header.

Figure 23 is a schematic diagram showing the syntax of a picture header.

Figure 24 is a schematic diagram showing the syntax of a picture cerding extension.

Figure 25 is a schematic diagram showing the syntax of picture data.

Figure 26 is a schematic diagram showing the data of a sequence layer, GOP layer, and picture layer.

Figure 27 is a block diagram showing the configuration of the multiplexing unit on the encoder side.

Figure 28 is a schematic diagram illustrating the method of generating PES and TS packets from source video data.

Figure 29 is a schematic diagram showing the data structure of a PES header.

Figure 30 is a schematic diagram showing picture sequences.

Figure 31 is a block diagram showing the configuration of an MPEG decoder.

#### Best Mode for Carrying Out the Invention

Figure 4 shows a broadcasting system consisting of a main broadcasting station 141 and local broadcasting station 171.

The main broadcasting station 141 comprises a plurality of editing/processing studios 145A to 145D, a plurality of MPEG encoders 142A to 142D, a plurality of MPEG decoders 144A to 144D, at least one multiplexer 162A, and at least one demultiplexer 161A. The broadcasting station 141 also includes an SDTI-CP (serial data transfer interface-content package) network 150 defined as SMPTE305M, through which each MPEG encoder, each MPEG decoder, the multiplexer 162A, and the demultiplexer 161A can send and receive elementary streams. SDTI-CP, which is a communications format proposed for transmission of elementary streams of MPEG, is defined as SMPTE305M. The elementary stream transferred over the SDTI-CP network 150 is expressed as ES\_over\_SDTI-CP.

The editing/processing studios 145A to 145D comprise video servers, video editors, special-effects devices, video switchers. They receive



decoded base-band video data from the MPEG decoders, edit it or subject it to image processing, and output it to the MPEG encoders. In other words, editing/processing studios 145A to 145D perform editing and image-processing operations on base-band video signals rather than performing stream processing operations on encoded streams.

The MPEG encoders 142A to 142D receive base-band input video signals from the editing/processing studios 145A to 145D, and encode them according to the MPEG standard described above to generate elementary streams (ES). The elementary streams generated by the MPEG encoders are supplied to either of the MPEG decoders 144A to 144D or the multiplexer 162A through the SDTI-CP network 150.

The MPEG decoders 144A to 144D receive the elementary streams supplied by the MPEG encoders 142A to 142D or the demultiplexer 161A through the SDTI-CP network 150, and decode them according to the MPEG standard. The multiplexer 162A is a circuit for multiplexing the plurality of video programs produced at the main broadcasting station 141 into one transport stream to distribute them to the local broadcasting station 171 or individual households. Specifically, it receives a plurality of elementary streams corresponding to the plurality of video programs through the SDTI-CP network 150, generates packetized elementary streams by packetizing the elementary streams, and then generates transport stream packets from the packetized elementary streams. The multiplexer 162A generates a multiplexed transport stream by multiplexing the transport stream packets generated

from the plurality of video programs. The configuration and processes of the multiplexer 162A will be described later.

If the destination of the plurality of video programs is the local broadcasting station 171, the multiplexed transport stream generated by the multiplexer 162A is supplied to the demultiplexer 161B of the local broadcasting station 171 through a network such as an ATM (asynchronous transfer mode) network or satellite line. The local broadcasting station 171 has exactly the same system configuration as the main broadcasting station 141 although they differ in scale, and thus detailed description will be omitted.

If the destination of the plurality of video programs is the local broadcasting station 171, the multiplexed transport stream generated by the multiplexer 162A is supplied to the MPEG decoder 170A contained in the set-top box at each household through a network such as an ATM (asynchronous transfer mode) network or satellite line, and decoded video data is supplied to the TV set.

Figure 5 illustrates the differences between an elementary stream transmitted via an SDTI-CP network within a broadcasting station and a transport stream transferred via a public network.

Within the broadcasting station, the elementary stream is transmitted via an SDTI-CP network. The SDTI-CP network 150, which uses a communications format based on the SDI (serial data interface) standardized by SMPTE259M and capable of a transfer rate of 270 Mbps, can transmit elementary streams (ES) in MPEG format directly and is suitable for closed networks such as studios. Specifically, video data

"V" and audio data "A" are packed in each frame and the stream can be edited easily along the frame boundaries defined by a frame sync (dotted line) as shown in Figure 5A.

Between broadcasting stations or over public networks, video data is transmitted in the form of a transport stream. In a transport stream, all contents including video data and audio data are encapsulated into 188-byte packets, as shown in Figure 5B, to allow data transmission even through a public network with a limited data-transmission capacity. As is the case with elementary streams, "V" indicates a transport stream packet of video data and "A" indicates a transport stream packet of audio data while a blank indicates a null packet.

Now the MPEG encoders 142A to 142D will be described with reference to Figure 6.

First, a supplementary explanation will be given about the input video data supplied to the MPEG encoders. In this embodiment, the input video data is 30-Hz video data generated by 3:2 pull-down conversion from source video data having a frame rate of 24 Hz. Specifically, the original source video data with a frame rate of 24 Hz consists of the frames F1, F2, and soon, each of which has two fields (top field t1, t2, ... and bottom field b1, b2, ...). As shown in Figure 7A, the 3:2 pull-down process generates a repeat field t1' by repeating the top field t1 in the first frame F1 -- where the top field should appear first -- to form one frame from three fields, and generates a repeat field b3' by repeating the bottom field b3 in the third frame F3 where the bottom field should appear first. In this way, the 3:2 pull-down

process can convert source video data with a frame rate of 24 Hz into video data with a frame rate of 30 Hz, as shown in Figure 7A, by alternating 3-field frames and 2-field frames.

Although in this embodiment input video data is generated by 3:2 pull-down, the present invention is not limited to video data whose input video data has undergone 3:2 pull-down. It can also be applied to video data that has not undergone 3:2 pull-down, provided the original source video has a frame rate of 30 Hz.

The MPEG encoder shown in Figure 6 comprises an ancillary data separating circuit 101, a field counter 102, a 2:3 pull-down circuit 103, an encoding controller 104, a motion vector detector 105, a switching circuit 111, a DCT circuit 112, a quantizing circuit 113, an inverse quantizing circuit 114, an inverse DCT circuit 115, an adding circuit 116, memories 117 and 118, a motion compensating circuit 119, arithmetic circuits 120, 121, and 122, a variable-length coding circuit 125, and a send buffer 126.

The ancillary data separating circuit 101 extracts ancillary data from the blanking interval of input video data. More particularly, as shown in Figure 8, it extracts the ancillary data inserted in the vertical blanking interval of input video data and the line number of the ancillary data. Such ancillary data includes, but is not limited to, text data, closed-captioning data, VITC (vertical interval time code) defined by SMPTE RP164, and LTC (linear time code) defined by RP196. In this embodiment, information about the extracted ancillary data is supplied to the controller 104 as Ancillary\_data while

information about the line number is supplied to the controller 104 as Line\_number. Also, information about VITC is supplied to the controller 104 as Time\_code\_1 and information about LTC is supplied to the controller 104 as Time\_code\_2.

Besides, the ancillary data separating circuit 101 extracts the unique information possessed by input video data. Such unique information may be, for example, data about the location of the active video area AR2 with respect to the full pixel area AR1 of input video data as shown in Figure 8. Specifically, it may include the number of lines that represents the vertical start position of the active video area and the number of samples that represents the horizontal start position. In this embodiment, the information about the vertical and horizontal positions of the active video area are supplied to the controller 104 as V-phase and H-phase, respectively. Other examples of the unique information includes the source name given to the input video data and the location and time of photo shooting.

The video data output from the ancillary data separating circuit 101 is supplied to the field counter 102 that follows. The field counter 102 is the circuit for counting the fields that compose each frame of the input video data. Then the field counter 102 supplies the count information of each frame to the controller 104 as Field\_ID. If, for example, the video data shown in Figure 7A is supplied to the field counter 102, Field\_ID of "0," "1," and "2" are output as the count information for frame F1, which has three fields, and Field\_ID of "0"

and "1" are output as the count information for frame F2, which has two fields.

The field counter 102 further comprises two counters that count the fields in the input video data and outputs the count information to the controller 104 as PTS\_counter and DTS\_counter.

When generating an ES header, PTS\_counter is used to generate presentation time stamps (PTSS) and DTS\_counter is used to generate decoding time stamps (DTSS).

Now PTS\_counter and DTS\_counter will be described in detail with reference to Figure 9.

Figure 9 shows the frame structure of each frame in the input video data as well as the relationship between PTS\_counter and DTS\_counter in each frame. Before going into details on Figure 9, a supplementary explanation will be given about the Repeat\_first\_field and Top\_field\_first flags. If the Repeat\_first\_field flag is set to "1," it indicates that a repeat field must be created during MPEG decoding and if the Repeat\_first\_field flag is set to "0," it indicates that a repeat field need not be created during MPEG decoding. The Top\_field\_first flag indicates whether the first field of the frame is the top field or bottom field: the value "1" indicates that the top field appears earlier than the bottom field in the frame while the value "0" indicates that the bottom field appears earlier than the top field in the frame.

Figure 9A illustrates the frame structure in the input video data described in Figure 7A. Specifically, the decoding of the first frame

F1 does not involve simply generating a frame consisting of a top field and bottom field, but it involves generating a frame consisting of three fields by creating a repeat field by copying the top field. Accordingly, the corresponding Repeat\_first\_field flag becomes "1" and the Top\_field\_first flag becomes "1."

In decoding frame F2, the Repeat\_first\_field flag is set to "0" because there is no need to generate a repeat field, and the Top\_field\_first flag is set to "0" because the bottom field appears earlier than the top field.

In decoding frame F3, the bottom field must be copied to create a repeat field and the coded frame must be converted into a three-field frame. Therefore, the Repeat\_first\_field flag is set to "1" and the Top\_field\_first flag is set to "0."

In decoding frame F4, there is no need to create a repeat field, so the Repeat\_first\_field flag is set to "0" and the Top\_field\_first flag is set to 1.

Since PTS\_counter is the time stamp information underlying the PTS as described above, it must agree with the frame order of input video data. Specifically, PTS\_counter is the value generated by a counter that increases from 0 to 127 and then returns to 0 again. The value of the counter PTS\_counter changes in the manner shown in Figure 9B.

More particularly, since the first frame F1 in input video data is an I-picture and must be presented first, the value of PTS\_counter is "0."

The value of PTS\_counter for the second frame F2 is the value "0" of PTS\_counter for frame F1 plus the number "3" of fields contained in frame F1, and thus is "3" ( $= 0 + 3$ ).

The value of PTS\_counter for the third frame F3 is the value "3" of PTS\_counter for frame F2 plus the number "2" of fields contained in frame F2, and thus is "5" ( $= 3 + 2$ ). The value of PTS\_counter for the fourth frame F4 is the value "5" of PTS\_counter for frame F3 plus the number "3" of fields contained in frame F2, and thus is "8" ( $= 5 + 3$ ). The value of PTS\_counter for the fifth frame F5 and subsequent frames are calculated in a similar manner.

Besides, since DTS\_counter is the time stamp information underlying the DTS, it must agree with the order of pictures in encoded streams rather than with the frame order of input video data.

Now this will be described in more concrete terms with reference to Figure 9C. Since the first frame F1 is an I-picture, it must be decoded one frame earlier than it is displayed. In other words, since frame F0 preceding the frame F1 consists of two fields, the value of DTS\_counter must be three fields ahead of the reference time "0," i.e., it must be "125," if the presentation time stamp PTS\_counter = 0 is used as the reference time. DTS\_counter is given as a value modulo 27 (= 128), and thus it cycles between 0 and 127.

The value of DTS\_counter for frame F4 encoded after frame F1 is equal to "0" ( $= 128 = 125 + 3$ ), which is given as the value "125" of DTS counter for frame F1 plus the number "3" of fields in frame F1.



Since frame F2 encoded next is a B-picture, the value of DTS\_counter is equal to the value of PTS\_counter, which is equal to "3." Similarly, frame F3 encoded next is a B-picture, and thus the value of DTS\_counter is equal to the value of PTS\_counter, which is equal to "5." The values of DTS\_counter for frame F7 and subsequent frames are calculated similarly and the description thereof will be omitted herein.

The field counter 102 generates PTS\_counter and DTS\_counter and supplies them to the controller 104 according to the rules described above.

The 2:3 pull-down circuit 103 receives the video data output from the field counter 102 and performs 2:3 pull-down. The 2:3 pull-down circuit 103 receives the video data with a frame rate of 30 Hz that has undergone 3:2 pull-down as shown in Figure 7A and generates video data with a frame rate of 24 Hz. More particularly, as shown in Figure 7B, the 2:3 pull-down circuit 7 converts video data with a frame rate of 30 Hz into video data with a frame rate of 24 Hz by removing the repeat fields t1' and b3' inserted by 3:2 pull-down. In removing repeat fields, the 2:3 pull-down circuit 103 analyzes the frame structure of the supplied video data and removes only the repeat fields that are found to occur at certain intervals. Thus, when analyzing the frame structure of video data, the 2:3 pull-down circuit 103 generates Repeat\_first\_field and Top\_field\_first flags as information about the frame structure and supplies them to the controller 104.

The motion vector detector 105 receives, in macroblocks, the video data output from the 2:3 pull-down circuit 103 and processes the image

data in each frame as an I-picture, P-picture, or B-picture according to a predetermined sequence. The question as to how to process the image of each frame -- as an I-picture, P-picture, or B-picture -- has been predetermined according to the GOP structure specified by the operator. Any motion vector MV detected is supplied to the controller 104 and motion compensating circuit 119.

When the intra-picture prediction mode is activated, the switching circuit 111 closes the contact a. Therefore, the macroblock data is transmitted to the transmission path through the DCT circuit 112, quantizing circuit 113, variable-length coding circuit 125, and send buffer 126, as is the case with I-picture data. The quantized data is also supplied to the frame memory 117 for backward predictive pictures through the inverse quantizing circuit 114, inverse DCT circuit 115, and arithmetic unit 116. On the other hand, when the forward prediction mode is activated, the switch 111 closes the contact b, the image data (the image data of the I-picture in this case) stored in the frame memory 118 for forward predictive pictures is read out, and compensation is made by the motion compensating circuit 119 based on the motion vector MV supplied by the motion vector detector 105. In other words, when instructed to activate the forward prediction mode, the motion compensating circuit 119 reads data to generate predicted picture data, by offsetting the read address of the frame memory 118 for forward predictive pictures from the location that corresponds to the location of the macroblock currently output by the motion vector detector 105 by the amount equivalent to the motion vector.

The predicted picture data output by the motion compensating circuit 119 is supplied to the arithmetic unit 120. Then, from the data in the macroblock of the reference image, the arithmetic unit 120 subtracts the predicted picture data supplied by the motion compensating circuit 119 and corresponding to the macroblock, and outputs the difference (prediction error). This differential data is transmitted to the transmission path through the DCT circuit 112, quantizing circuit 113, variable-length coding circuit 125, and send buffer 126. Also, this differential data is decoded locally by the quantizing circuit 114 and inverse DCT circuit 115, and is input to the arithmetic unit 116.

The arithmetic unit 116 has also been supplied with the same data as the predicted picture data supplied to the arithmetic unit 120. The arithmetic unit 116 adds the predicted picture data output by the motion compensating circuit 119, to the differential data output by the inverse DCT circuit 115. This produces the image data of the original (decoded) P-picture. The image data of the P-picture is supplied to the backward predictive picture section of the frame memory 117, where it is stored.

After the data of the I-picture and P-picture is stored in the forward predictive picture section 118 and the backward predictive picture section 117, respectively, the motion vector detector 105 processes the next picture, B-picture. In intra-picture prediction mode or forward prediction mode, the switch 111 closes the contacts a or b, respectively. The picture is processed in the same manner as P-pictures and the data is transmitted.

On the other hand, when the backward prediction mode or bidirectional prediction mode is activated, switch 111 closes the contact c or d, respectively.

In backward prediction mode with the contact c in the switch 111 closed, the image data (images of the P-picture in this case) stored in the backward predictive picture section 117 is read out and has its motion compensated by the motion compensating circuit 119 according to the motion picture output by the motion vector 105. In other words, when the backward prediction mode is activated, the motion compensating circuit 119 reads data to generate predicted picture data, by offsetting the read address of the backward predictive picture section 117 from the location that corresponds to the location of the macroblock currently output by the motion vector detector 105 by the amount equivalent to the motion vector.

The predicted picture data output by the motion compensating circuit 119 is supplied to the computing unit 121. Then the computing unit 121 subtracts the predicted picture data supplied by the motion compensating circuit 119, from the data in the macroblock of the reference image and outputs the difference. This differential data is transmitted to the transmission path through the DCT circuit 112, quantizing circuit 113, variable-length coding circuit 125, and send buffer 126.

In bidirectional prediction mode with the contact d in the switch 111 closed, the image data (images of the I-picture in this case) stored in the forward predictive picture section 118 and image data (images

of the P-picture in this case) stored in the backward predictive picture section 117 are read out and have their motions compensated by the motion compensating circuit 119 according to the motion picture output by the motion vector detector 105.

In other words, when the bidirectional prediction mode is activated, the motion compensating circuit 119 reads data to generate predicted picture data, by offsetting the read addresses of the forward predictive picture section 118 and backward predictive picture section 117 from the locations that correspond to the locations of the macroblock currently output by the motion vector detector 105 by the amount equivalent to the motion vectors (for both forward predictive picture and backward predictive picture, in this case). The predicted picture data output by the motion compensating circuit 119 is supplied to the computing unit 122. Then the computing unit 122 subtracts the average of the predicted picture data supplied by the motion compensating circuit 119, from the data in the macroblock of the reference image supplied by the motion vector detector 105 and outputs the difference. This differential data is transmitted to the transmission path through the DCT circuit 112, quantizing circuit 113, variable-length coding circuit 125, and send buffer 126.

The images of B-pictures are not stored in the frame memories 117 and 118 because they are not used as predicted pictures for other pictures.

The controller 104 controls all the circuits involved in the prediction mode processing, DCT mode processing, and quantization

processing described above. Besides, the controller 104 supplies all the coding parameters, including motion vectors, picture types, prediction modes, DCT modes, quantizing steps, generated during the encoding of pictures to the variable-length coding circuit 125.

Furthermore, the controller 104 receives V-phase, H-phase, Time\_code1, Time\_code2, Ancillary\_data, and Line\_number information from the ancillary data separating circuit 101 and receives DTS\_counter, PTS\_counter, and Field\_ID information from the field counter 102. Then it supplies the received V-phase, H-phase, Time\_code1, Time\_code2, Ancillary\_data, Line\_number, DTS\_counter, PTS\_counter, and Field\_ID information to the variable-length coding circuit 125 as MPEG\_ES\_editing\_information (i).

The variable-length coding circuit 125 converts the quantized DCT coefficient received from the quantizing circuit 113 and coding parameters received from the controller 104 into variable-length codes to generate an encoded stream according to the syntax of elementary streams specified by the MPEG standard.

A characteristic feature of this embodiment is that the variable-length coding circuit 125 also converts the information supplied from the controller 104 as MPEG\_ES\_editing\_information (i) into variable-length codes and inserts them into the encoded stream. The syntax of encoded streams and the syntax of MPEG\_ES\_editing\_information (i) will be described in detail later.

Now the syntax of bit streams will be described with reference to Figures 10 to 26. Incidentally, Figure 26 is an explanatory drawing

illustrating the data structure of an MPEG encoded stream in an easy-to-understand form while Figures 10 to 25 describe the syntax in detail.

Figure 10 shows the syntax of a video stream of MPEG. The MPEG encoder 42 generates encoded elementary streams according to the syntax shown in Figure 10. In the descriptions of syntaxes that follow, functions and conditional statements are shown in lightface while data elements are shown in boldface. Data items are expressed in mnemonic form that represents their name, bit length, type, and transmission order.

First the functions used in the syntax shown in Figure 10 will be described. Actually, the syntax shown in Figure 10 is used by the MPEG encoder 44 to extract meaningful data elements from the encoded bit stream received. The syntax used by the MPEG encoder 42 is the syntax obtained by omitting the conditional statements such as if and while statements from the syntax shown in Figure 10.

`next_start_code()` described first in `video_sequence()` is designed to search a bit stream for a start code. In any encoded stream generated according to the syntax shown in Figure 10, the data element defined by `sequence_header()` and `sequence_extension()` are described first. The `sequence_header()` function is used to define header data for the sequence layer of an MPEG bit stream while the `sequence_extension()` function is used to define extension data for the sequence layer of the MPEG bit stream.

The "do { } while" syntax placed next to the `sequence_extension()` function indicates that the data elements described based on the function in the braces { } of the do statement will remain in the encoded data stream while the condition defined by the while statement is true. The `nextbits()` function contained in the while statement is used to compare the bits or bit string described in the bit stream with the data elements referenced. In the example shown in Figure 10, the `nextbits()` function compares the bit string in the bit stream with `sequence_end_code` that indicates the end of the video sequence, and if they do not match, the condition in the while statement holds true. Therefore, the "do { } while" syntax placed next to the `sequence_extension()` function indicates that the data elements defined by the function in the do statement will remain in the encoded bit stream until `sequence_end_code` that indicates the end of the video sequence is encountered.

In the encoded bit stream, following the data elements defined by the `sequence_extension()` function, the data elements defined by `extension_and_user_data(0)` have been described. The `extension_and_user_data(0)` function is used to define extension data and user data for the sequence layer of an MPEG bit stream. The "do { } while" syntax placed next to `extension_and_user_data(0)` indicates that the data elements described based on the function in the braces { } of the do statement will remain in the bit stream while the condition defined by the while statement is true. The `nextbits()` function contained in the while statement is used to determine the match between



the bits or bit string in the bit stream and picture\_start\_code or group\_start\_code. If the bits or bit string in the bit stream and picture\_start\_code or group\_start\_code match, the condition defined by the while statement holds true. Therefore, the "do { } while" syntax indicates that if picture\_start\_code or group\_start\_code appears in the encoded bit stream, the data element codes defined by the function in the do statement are described next to the start code. The if statement described at the beginning of the do statement specifies the condition that group\_start\_code appears in the encoded bit stream. If the condition presented by the if statement is true, the data elements defined by group\_of\_picture\_header() and extension\_and\_user\_data(1) are described in sequence next to group\_start\_code in the encoded bit stream. The group\_of\_picture\_header() function is used to define header data for the GOP layer of an MPEG encoded bit stream while the extension\_and\_user\_data(1) function is used to define extension data and user data for the GOP layer of the MPEG encoded bit stream.

Besides, in this encoded bit stream, next to the data elements defined by group\_of\_picture\_header() and extension\_and\_user\_data(1), data elements defined by picture\_header() and picture\_coding\_extension() have been described. Of course, if the condition of the if statement described above does not hold true, the data elements defined by group\_of\_picture\_header() and extension\_and\_user\_data(1) are not described, and thus next to the data elements defined by extension\_and\_user\_data(0), the data elements

defined by `picture_header()`, `picture_coding_extension()` and `extension_and_user_data(2)` are described.

The `picture_header()` function is used to define header data for the picture layer of an MPEG encoded bit stream while the `picture_coding_extension()` function is used to define first extension data for the picture layer of the MPEG encoded bit stream. The `extension_and_user_data(2)` function is used to define extension data and user data for the picture layer of the MPEG encoded bit stream. The user data defined by `extension_and_user_data(2)` has been defined in the picture layer and can be defined for each picture.

In the encoded bit stream, next to the user data in the picture layer, the data elements defined by `picture_data()` have been described. The `picture_data()` function is used to describe data elements associated with a slice layer and macroblock layer.

The while statement described next to the `picture_data()` function is the function used to judge the condition of the next if statement while the condition defined by the while statement is true. The `nextbits()` function contained in the while statement is used to determine whether `picture_start_code` or `group_start_code` has been described in the encoded bit stream. If `picture_start_code` or `group_start_code` has been described in the encoded bit stream, the condition defined by the while statement holds true.

The if statement that appears next is the conditional statement used to determine whether `sequence_end_code` has been described in the encoded bit stream. It indicates that if `sequence_end_code` has not

been described, the data elements defined by `sequence_header()` and `sequence_extension()` have been described. Since `sequence_end_code` is the code that indicates the end of the sequence of an encoded video stream, the data elements defined by `sequence_header()` and `sequence_extension()` should remain in the encoded video stream unless the encoded video stream has ended.

The data elements described here by `sequence_header()` and `sequence_extension()` are exactly the same as the data elements described by `sequence_header()` and `sequence_extension()` at the beginning of the sequence of the video stream. In this way, the same data is described in a stream more than once to avoid cases in which it will become impossible to receive sequence layer data and decode the stream when the data stream is received from the middle (e.g., the part of the bit stream that corresponds to the picture layer) by the bit stream receiver.

After the data elements defined by the last `sequence_header()` and `sequence_extension()`, i.e., at the end of the data stream, two-bit `sequence_end_code` is described indicating the end of the sequence.

Now detailed description will be given of `sequence_header()`, `sequence_extension()`, `extension_and_user_data(0)`, `group_of_picture_header()`, `picture_header()`, `picture_coding_extension()`, and `picture_data`.

Figure 11 illustrates the syntax of `sequence_header()`. The data elements defined by `sequence_header()` include `sequence_header_code`, `horizontal_size_value`, `vertical_size_value`,

aspect\_ratio\_information, frame\_rate\_code, bit\_rate\_value,  
marker\_bit, vbv\_buffer\_size\_value, constrained\_parameter\_flag,  
load\_intra\_quantizer\_matrix, intra\_quantizer\_matrix[64],  
load\_non\_intra\_quantizer\_matrix, non\_intra\_quantizer\_matrix, etc.

sequence\_header\_code is the data that represents the start  
synchronization code of the sequence layer. horizontal\_size\_value is  
the data that consists of the low-order 12 bits of the horizontal pixel  
count of an image. vertical\_size\_value is the data that consists of  
the low-order 12 bits of the vertical line count of an image.  
aspect\_ratio\_information is the data that represents the aspect ratio  
of a pixel or a display screen. frame\_rate\_code is the data that  
represents the display cycle of an image. bit\_rate\_value is the data  
that consists of the low-order 18 bits (rounded up to the nearest  
multiple of 400 bps) of the bit rate used to limit the amount of bits  
generated. marker\_bit is the bit data that is inserted to avoid start  
code emulation. vbv\_buffer\_size\_value represents the low-order 10  
bits of the value that determines the size of the virtual buffer (video  
buffer verifier) for controlling the amount of codes generated.  
constrained\_parameter\_flag is the data which indicates that parameters  
fall within limits. load\_intra\_quantizer\_matrix is the data that  
indicates the existence of quantization matrix data for intra MB.  
intra\_quantizer\_matrix[64] is the data that represents the value of  
the quantization matrix for intra MB.  
load\_non\_intra\_quantizer\_matrix is the data that indicates the  
existence of quantization matrix data for non-intra MB.

non\_intra\_quantizer\_matrix is the data that represents the value of the quantization matrix for non-intra MB.

Figure 12 illustrates the syntax of sequence\_extension(). The data elements defined by sequence\_extension() include extension\_start\_code, extension\_start\_code\_identifier, profile\_and\_level\_indication, progressive\_sequence, chroma\_format, horizontal\_size\_extension, vertical\_size\_extension, bit\_rate\_extension, vbv\_buffer\_size\_extension, low\_delay, frame\_rate\_extension\_n, frame\_rate\_extension\_d, etc.

extension\_start\_code is the data that represents the start synchronization code of extension data.

extension\_start\_code\_identifier is the data that indicates which extension data will be sent. profile\_and\_level\_indication is the data used to specify the profile and level of video data.

progressive\_sequence is the data which indicates that video data is to be scanned sequentially. chroma\_format is the data used to specify the color difference format of video data. horizontal\_size\_extension represents the high-order 2 bits of the data to be added to horizontal\_size\_value in the sequence header.

vertical\_size\_extension represents the high-order 2 bits of the data to be added to vertical\_size\_value in the sequence header.

bit\_rate\_extension represents the high-order 12 bits of the data to be added to bit\_rate\_value in the sequence header.

vbv\_buffer\_size\_extension represents the high-order 8 bits of the data to be added to vbv\_buffer\_size\_value in the sequence header. low\_delay

is the data which indicates that no B-picture is included.

frame\_rate\_extension\_n is used in conjunction with frame\_rate\_code in the sequence header to obtain the frame rate. frame\_rate\_extension\_d is used in conjunction with frame\_rate\_code in the sequence header to obtain the frame rate.

Figure 13 illustrates the syntax of extension\_and\_user\_data(i). When "i" is other than 1, extension\_and\_user\_data(i) describes only the data elements defined by user\_data(), and not the data elements defined by extension\_data(). Therefore, extension\_and\_user\_data(0) describes only the data elements defined by user\_data().

First, the functions used by the syntax shown in Figure 13 will be described. The nextbits() function is used to compare the bits or bit string in the bit stream with the data element to be decoded next.

user\_data() in Figure 14 illustrates the characteristic features of this embodiment. As shown in Figure 14, the user\_data() function is used to describe the data elements associated with user\_data\_start\_code, V-phase(), H-phase(), Time\_code(), Picture\_order(), Ancillary\_data(), history\_data(), and user\_data().

user\_data\_start\_code is the start code used to indicate the start of the user data area in the picture layer of an MPEG bit stream. The if statement described next to this code specifies to run the while syntax that follows if i in user\_data(i) is "0." The while syntax remains true unless 24-bit data consisting of twenty-three "0's" and accompanying "1" appears in the bit stream.

The 24-bit data consisting of twenty-three "0's" and accompanying "1" is added to the beginning of all start codes, allowing the nextbits() function to find the location of each of the start codes in the bit stream.

If the while statement is true, it follows that i in user\_data(i) is "0," and thus there should be extension\_and\_user\_data(0) in the sequence layer. This means that in the sequence layer in Figure 26, data elements associated with extension\_and\_user\_data(0) 205 have been described. If a bit string (Data\_ID) representing V-Phase is detected, the nextbits() function in the next if statement knows that the subsequent bits describe the V-Phase data elements indicated by V-Phase(). If a bit string (Data\_ID) representing H-Phase is detected, the nextbits() function in the next Else if statement knows that the subsequent bits describe the H-Phase data elements indicated by H-Phase().

This means that the data elements associated with V-Phase() 220 and H-Phase() 221 have been described in the user data area of the sequence layer as shown in Figure 26.

As shown in Figure 15, Data\_ID of V-Phase is a bit string representing "01." Data\_ID of H-Phase is a bit string representing "02."

Now the syntax of V-Phase() described in the bit stream will be explained with reference to Figure 16. As described above, Data\_ID is the 8-bit data which indicates that the data elements of the next bit string is V-Phase, i.e., the value "01" shown in Figure 15. V-Phase

is the 16-bit data that indicates the first line to be encoded in a video signal frame. In other words, V-Phase is the data that indicates the vertical line number of the active video area.

Now the syntax of H-Phase() described in the bit stream will be explained with reference to Figure 17. As described above, Data\_ID is the 8-bit data which indicates that the data elements of the next bit string is H-Phase, i.e., the value "02" shown in Figure 15. H-Phase is the 8-bit data that indicates the first sample to be encoded in a video signal frame. In other words, H-Phase is the data that indicates the horizontal pixel sample position of the active video area.

Returning to Figure 14, the next Else if statement executes the next while syntax if i in extension\_and\_user\_data(i) is 2. Description of the while syntax will be omitted because it has the same meaning as the while syntaxes described above.

When the while syntax is true, if a bit string indicating Time code1 or Time code2 is detected, the nextbits() function in the next if statement knows that the subsequent bits describe the time code data elements indicated by Time\_code(). This means that if i in extension\_and\_user\_data(i) is 2, this user data is contained in the picture layer. That is, the data elements represented by Time\_code() 241 have been described in the user data area of the picture layer as shown in Figure 26.

Data\_ID of Time code1 is a bit string representing "03" as shown in Figure 15. Time code1 data is the VITC (vertical interval time code) that represents the time code inserted in the vertical blanking interval



of an image. Data\_ID of Time code2 is a bit string representing "04" as shown in Figure 15. Time code2 data is the LTC (longitudinal time code or linear time code) that represents the time code recorded on the time code track of the recording medium.

Figures 18 and 19 show the syntax of Time code (). As shown in Figure 18, the time code consists of 72-bit data. Figure 19 shows the concrete data structure.

In Figure 19, color\_frame\_flag represents the control flag of color frame information while Drop\_frame\_flag that follows represents the control flag of dropped frames. The six bits from the third bit to the eighth bit represent the 'frame' section of the time code: field\_phase represents the control flag of phase correction. The seven bits from the 10th bit to the 16th bit represent the 'seconds' section of the time code. The '1' in the 17th, 34th, 51st, and 68th bits is a marker bit used to prevent 0 from occurring 23 times successively. The insertion of the marker bit at certain intervals can prevent start code emulation.

binary\_group in the 18th, 26th, and 27th bits represents a control flag for binary groups. The seven bits from the 19th bit to the 25th bit represent the 'minutes' section of the time code while the six bits from the 28th bit to the 33rd bit represent the 'hours' section of the time code.

In Figure 14, if a bit string indicating a picture order is detected, the nextbits() function in the Else if statement knows that the subsequent bits describe the picture order data elements indicated by

Picture\_Order(). Data\_ID of Picture\_Order() is a bit string representing "05" as shown in Figure 15.

Now the syntax of Picture\_Order() inserted actually into the elementary stream (ES) by the encoder will be described with reference to Figure 20. As described above, Data\_ID is the 8-bit data which indicates that the subsequent data is the Picture\_Order data and its value is "05." DTS\_presence is the 1-bit data that indicates the presence or absence of the coding order DTS\_counter. For example, if DTS\_counter = PTS\_counter as in the case of B-pictures, only the presentation order PTS\_counter exists and the bit of DTS\_presence becomes "0." Conversely, in case of P-pictures and I-pictures, the coding order DTS\_counter and presentation order PTS\_counter are not equal, so both coding order DTS\_counter and presentation order PTS\_counter exist and the bit of DTS\_presence becomes 1. As described in Figure 26, the data elements associated with Picture\_Order() are described in the user data area of the picture layer as is the case with Time\_Code().

As described above, PTS\_counter is the value generated by the field counter 102 in the MPEG encoder. It is the 7-bit data which represents the presentation order and which is incremented by 1 each time one field of the input video data is filled. This 7-bit data is given as the remainder of modulo division and takes on values from 0 to 127. The if statement indicates that DTS\_counter is incremented if the bit of DTS\_presence is 1, i.e., in the case of a P-picture and I-picture.

Marker\_bits is inserted every 16 bits to prevent start code emulation, a phenomenon in which a described bit string of user data accidentally matches the start code described above leading to a high possibility of image corruption.

DTS\_counter is the value generated by the field counter 102 in the MPEG encoder. It is the 7-bit data which represents the coding order and which is incremented by 1 each time one field of the input video data is encoded. This 7-bit data is given as the remainder of modulo division and takes on values from 0 to 127.

Returning to Figure 14, the while syntax has the same meaning as the while syntaxes described above, and thus description thereof will be omitted. When the while syntax is true, if a bit string indicating ancillary data is detected, the nextbits() function in the next if statement knows that the subsequent bits describe the ancillary data elements indicated by Ancillary\_data(). Data\_ID of Ancillary\_data() is a bit string representing "07" as shown in Figure 15. As shown in Figure 26, the data elements associated with Ancillary\_data() have been described in the user data area of the picture layer as is the case with Picture\_Order() and Time\_Code().

Now the syntax of Ancillary\_data() that adds identifiers to ancillary data will be described with reference to Figure 21. Ancillary\_data(), which is inserted as user data in the picture layer, includes a field identifier (Field\_ID), a line number (Line\_number), and ancillary data.

Data\_ID is 8-bit data which is an ancillary data in the user data area, having a value of "07" as shown in Figure 15.

Field\_ID is the 2-bit data that is added to each field in coded frames when the value of progressive\_sequence\_flag, which indicates whether the input video data is progressive video, is "0," i.e., when the input video data is interlaced video data.

Now Field\_ID will be described with reference to Figure 7.

If repeat\_first\_field contains "0," the given frame has two fields: Field\_ID of the first field is set to "0" and Field\_ID of the second field is set to "1." If repeat\_first\_field contains "1," the given frame has three fields: Field\_ID of the first, second, and third fields is set to "0," "1," and "2," respectively.

Now more detailed description will be provided with reference to Figure 7C. The encoded stream shown in Figure 7C is obtained when the input video data shown in Figure 7B is encoded. This encoded stream is an elementary stream consisting of a plurality of access units (AU1, AU2, ...). Figure 7C shows the ancillary data and Field\_ID information described in the elementary stream.

Frame F1 of this encoded stream contains 0, 1, and 2 as Field\_ID. In other words, when Field\_ID = 0, ancillary data "0" about that field is described in the stream, when Field\_ID = 1, ancillary data "1" about that field is described in the stream, and when Field\_ID = 2, ancillary data "2" about that field is described in the stream. This means that in the picture of frame F1, the data elements associated with

Ancillary\_data() 243 are repeated as many times as the number of the fields in frame F1, as shown in Figure 26.

Field\_ID is added for each coded frame when the value of progressive\_sequence\_flag, is "1," i.e., when the input video data is 1. If both repeat\_first\_field and Top\_field\_first contain Field\_ID of "0," the given coded frame has one progressive frame and thus "0" is set. If repeat\_first\_field contains "1" and Top\_field\_first contains "0," the given coded frame has two progressive frames and thus "0" and "1" are set. If both repeat\_first\_field and Top\_field\_first contain "1," the given coded frame has three progressive frames and thus "0" to "2" is set.

Line\_number is 14-bit data which represents the line number of the line where the ancillary data of each frame is described. This line number has been specified by ITU-R, BT.656-3, SMPTE274M, SMPTE293M, and SMPTE296M.

Ancillary\_data\_length is the 16-bit data which represents the data length of ancillary\_data\_payload. Ancillary\_data\_payload represents the content of 22-bit ancillary data. If the value of Ancillary\_data\_length for Ancillary\_data\_payload is larger than the value j (default of 0), the value j (data length of Ancillary\_data\_length) is incremented by 1 and description starts from the bit string of the value j.

The While syntax that follows shows the syntax of bytealigned(). It describes Zero\_bit (1-bit data "0") when the next data is not bytealigned() (when the While syntax is true).

Returning to Figure 14, if a bit string indicating history data is detected, the nextbits() function in the next Else if statement knows that the subsequent bits describe the data elements of history data indicated by History\_data(). Data\_ID of History\_data() is a bit string representing "08" as shown in Figure 15. The data represented by Data\_ID of "08" represents history data that includes the history information of coding parameters. History\_data() is described in detail in U.S. patent application Ser. No. 09/265,723, and thus description thereof is omitted herein.

If a bit string indicating user data is detected, the `nextbits()` function in the final `if` statement knows that the subsequent bits describe the `user_data` data elements indicated by `user_data()`.

The bit strings from which the `nextbits()` functions in Figure 14 know that the subsequent bits describe appropriate data elements are described as `Data_ID` shown in Figure 15. However, the use of "00" as `Data_ID` is prohibited. The data represented by `Data_ID` of "80" represents a control flag while the data represented by `Data_ID` of "FF" represents user data.

Figure 22 illustrates the syntax of `group_of_picture_header()`. The data element defined by `group_of_picture_header()` consists of group start code, time\_code, closed\_gop, and broken\_link.

group\_start\_code is the data that represents the start synchronization code of the GOP layer. time\_code represents the time from the beginning of the sequence of the first picture in the GOP. closed\_gop is the flag which indicates that the images in the GOP can

be played back independent of other GOPs. `broken_link` is the flag which indicates that the B-picture at the beginning of GOP cannot be played back correctly due to editing. The `extension_and_user_data(1)` function is used to describe only the data elements defined by `user_data()`, as is the case with `extension_and_user_data(0)`.

Now, with reference to Figures 23 to 25, description will be given of `picture_header()`, `picture_coding_extension()`, and `picture_data()` used to describe data elements associated with the picture layer of encoded streams.

Figure 23 illustrates the syntax of `picture_header()`. The data elements defined by `picture_header()` include `picture_start_code`, `temporal_reference`, `picture_coding_type`, `vbv_delay`, `full_pel_forward_vector`, `forward_f_code`, `full_pel_backward_vector`, `backward_f_code`, `extra_bit_picture`, and `extra_information_picture`.

Specifically, `picture_start_code` is the data that represents the start synchronization code of the picture layer. `temporal_reference` is the number that indicates the presentation order of pictures and is reset at the beginning of a GOP. `picture_coding_type` is the data that represents a picture type.

`vbv_delay` is the data that represents the initial state of a VBV buffer and is set for each picture. The pictures in the encoded elementary stream transmitted from the sending system to the receiving system is placed in the VBV buffer provided in the receiving system, fetched (read out) from this VBV buffer at the time specified by the DTS (decoding time stamp), and supplied to the decoder. The time

defined by `vbv_delay` is the period from the moment the picture to be decoded is started to be placed in the VBV buffer until the picture to be encoded is read out from the VBV buffer, i.e., until the time defined by the DTS. The use of `vbv_delay` stored in the picture header allows seamless splicing avoiding discontinuity in the occupancy of the VBV buffer.

`full_pel_forward_vector` is the data that indicates whether the accuracy of forward motion vectors should be expressed in integers or half-pixels. `forward_f_code` is the data that indicates the search range of forward motion vectors. `full_pel_backward_vector` is the data that indicates whether the accuracy of backward motion vectors should be expressed in integers or half-pixels. `backward_f_code` is the data that indicates the search range of backward motion vectors. `extra_bit_picture` is the flag that indicates the existence of subsequent additional information. If `extra_bit_picture` is "1," `extra_information_picture` follows. If `extra_bit_picture` is "0", no subsequent data exists. `extra_information_picture` is the information reserved by the standard.

Figure 24 illustrates the syntax of `picture_coding_extension()`. The data elements defined by `picture_coding_extension()` include `extension_start_code`, `extension_start_code_identifier`, `f_code[0][0]`, `f_code[0][1]`, `f_code[1][0]`, `f_code[1][1]`, `intra_dc_precision`, `picture_structure`, `top_field_first`, `frame_predictive_frame_dct`, `concealment_motion_vectors`, `q_scale_type`, `intra_vlc_format`, `alternate_scan`, `repeat_first_field`, `chroma_420_type`,



progressive\_frame, composite\_display\_flag, v\_axis, field\_sequence, sub\_carrier, burst\_amplitude, and sub\_carrier\_phase

extension\_start\_code indicates the start of extension data in the picture layer. extension\_start\_code\_identifier is the code that indicates what extension data is sent. f\_code[0][0] is the data that indicates the search range of forward horizontal motion vectors. f\_code[0][1] is the data that indicates the search range of forward vertical motion vectors. f\_code[1][0] is the data that indicates the search range of backward horizontal motion vectors. f\_code[1][1] is the data that indicates the search range of backward vertical motion vectors. intra\_dc\_precision is the data that represents the accuracy of the DC coefficient. picture\_structure is the data that indicates whether the picture has a frame structure or field structure. In the case of the field structure, it also indicates whether the field is an upper field or lower field. top\_field\_first is the flag that indicates whether the first field is the top field or bottom field in the case of the frame structure. frame\_predictive\_frame\_dct is the data which indicates that the frame mode DCT prediction is only in the frame mode in the case of the frame structure.

concealment\_motion\_vectors is the data which indicates that intra-macroblocks are provided with motion vectors for hiding transmission errors. q\_scale\_type is the data that indicates which quantization scale to use, linear or non-linear. intra\_vlc\_format is the data that indicates whether to use another two-dimensional VLC (variable-length code) for intra-macroblocks. alternate\_scan is the data that indicates



extra\_information\_slice as well as the data elements defined by macroblock ().

slice\_start\_code indicates the start of the data elements defined by slice(). slice\_quantiser\_scale\_code is the data that indicates the size of the quantizing step specified for the macroblocks in the slice layer. If quantiser\_scale\_code has been specified for each macroblock, however, the macroblock\_quantiser\_scale\_code takes precedence. intra\_slice\_flag indicates the presence or absence of intra\_slice and reserved\_bits in the bit stream. intra\_slice is the data that indicates the presence or absence of a non-intra macroblock in the slice layer. If any of the macroblocks in the slice layer is a non-intra macroblock, intra\_slice is set to "0." If all the macroblocks in the slice layer are non-intra macroblocks, intra\_slice is set to "1." reserved\_bits is 7-bit data which takes on the value of "0." extra\_bit\_slice is the flag that indicates the presence of additional information as an encoded stream. It is set to "1" if extra\_information\_slice follows. It is set to "0" if no additional information exists.

The macroblock () function is used to describe the data elements associated with a macroblock layer. Specifically, it is used to describe data elements such as macroblock\_escape, macroblock\_address\_increment, and macroblock\_quantiser\_scale\_code as well as the data elements defined by macroblock\_modes() and macroblock\_vectors().

macroblock\_escape is the fixed bit string that indicates whether the horizontal difference between the reference macroblock and previous

macroblock is equal to or more than 34. If the horizontal difference is 34 or larger, 33 is added to the value of macroblock\_address\_increment. macroblock\_address\_increment is the data that represents the horizontal difference between the reference macroblock and previous macroblock. If macroblock\_address\_increment is preceded by one macroblock\_escape string, the actual horizontal difference between the reference macroblock and previous macroblock is the value of macroblock\_address\_increment plus 33.

macroblock\_quantiser\_scale\_code represents the size of the quantization step specified for each macroblock. Although slice\_quantiser\_scale\_code has been specified for each slice layer to indicate the quantization step size of the slice layer, the quantization step size of the reference macroblock is selected if macroblock\_quantiser\_scale\_code has been specified for the reference macroblock.

Now the multiplexer 162A will be described with reference to Figure 27.

The multiplexer 162A comprises a plurality of packetizers 301 to 309, a plurality of transport stream generators (TS Gen.) 311 to 319, a plurality of system target decoder buffers (STD buffers) 321 to 329, a multiplexing circuit 330, and a multiplexing controller 300.

The packetizers 301 to 309 receive the respective elementary streams output by MPEG encoders and packetize the elementary streams to generate packetized elementary streams (PES).

Figure 28 illustrates the relationship among an elementary stream (ES), a packetized elementary stream (PES), and transport stream packets.

When source video data is encoded, an elementary stream, such as the one shown in Figure 28B, consisting of access units AU1, AU2, ... is generated. Figure 28C illustrates packetization performed by a packetizer. The packetizer packetizes a plurality of access units and adds a PES header to the beginning of the packet.

Figure 29 illustrates the PES header. As shown in the figure, the PES header consists of Packet Start Code, Stream ID, Packet Length, symbol "10," Flag Control Code, PES Header Length, and Conditional Coding. The MPEG standard stipulates that the conditional coding must contain presentation time stamp (PTS) and decoding time stamp (DTS) information.

Each of the transport stream generators (TS Gen.) 311 to 319 generate a transport stream consisting of 188-byte transport stream packets from the packetized elementary streams output by the packetizers 301 to 309, as shown in Figure 28D.

The system target decoder buffers (STD buffers) 321 to 329 receive the transport streams output by the transport stream generators 311 to 319 and buffer them. The STD buffers are fixed-capacity buffers specified by the MPEG standard and are provided for the purpose of simulation to prevent receive buffer from overflowing and underflowing on the MPEG decoder side.

The multiplexing circuit 330 receives a transport stream from each of the system target decoder buffers 321 to 329 and multiplexes the transport streams according to the schedule set by the controller 300.

Next, the configuration and processes of the packetizers will be described in detail with reference to Figures 27 and 30.

Each of the packetizer comprises a buffer 341 for buffering the elementary streams received, a parsing circuit 342 for parsing the syntax of the elementary streams received, and packetizing circuit 343 for packetizing the elementary streams output from the buffer.

The parsing circuit 342 extracts PTS\_counter and DTS\_counter described in the elementary stream and supplies them to the packetizing circuit 343. More particularly, the parsing circuit 342 converts the received elementary stream into variable-length codes and searches the elementary stream for start codes and other special data elements. Since the purpose of this parsing process is to extract PTS\_counter and DTS\_counter, the parsing process searches for the start code of the picture layer, ignoring the start code of the sequence and GOP layers. Next, the parsing process can find out the user data area of the picture layer by finding out 32-bit user\_data\_start\_code from the stream. Then it searches for Data\_ID of "05" to find out data elements associated with Picture\_order() in this user data area. The parsing circuit 342 extracts PTS\_counter and DTS\_counter described in the 10th to 16th bits and 17th to 23rd bits of this Picture\_order() function, respectively, and supplies them to the packetizing circuit 343.

The packetizing circuit 343 receives PTS\_counter and DTS\_counter from the parsing circuit 342 and based on this PTS\_counter and DTS\_counter information, generates PTS and DTS anew. This embodiment uses the value of PTS\_counter itself as the PTS value and uses the value of DTS\_counter as the DTS value.

Figure 30 illustrates the minimum delay produced when the packetizer of this embodiment is used. Figure 30A shows input video data, Figure 30B shows the elementary stream obtained when the input video data is encoded, and Figure 30C shows the packetized elementary stream obtained by using the encoded stream generated by the MPEG encoder of this embodiment and packetizer of this embodiment.

Figures 30A and 30B are almost the same as Figures 2A and 2B. However, as can be seen by comparing Figure 2C and Figure 30C, conventional methods generate a packetized elementary stream that determines PTS. Thus, as described earlier, if the number of B-pictures existing between an I-picture and P-pictures is denoted as N, there is a delay of  $(N + 2)$  frames in the PTS determination process.

The encoding method and packetizing method of this embodiment can limit the delay produced in the process of determining PTS from an encoded stream, to one frame time. Furthermore, regardless of the number of B-pictures existing between an I-picture and P-pictures, the delay can be kept to the minimum delay of one frame. Besides, when designing a 9-channel packetizer such as the one shown in Figure 27, this embodiment has an extremely great advantage of allowing to implement such a packetizer with nine frame memories.

Now the MPEG decoders 144A to 144D will be described with reference to Figure 31. Each of the MPEG decoders comprises a receive buffer 401, a variable-length decoding circuit 402, an inverse quantizing circuit 403, an inverse DCT circuit 404, a controller 405, an arithmetic unit 411, a motion compensating circuit 412, memories 413 and 414, a send buffer 415, a base-band video generation circuit 416, and a multiplexing circuit 417.

The variable-length decoding circuit 402 receives an elementary stream from the receive buffer and performs a variable-length decoding operation on it to generate a stream consisting of data elements with a predetermined data length. Then, the variable-length decoding circuit 402 parses the syntax of the data stream that has been subjected to variable-length decoding, thereby extracting all coding parameters from the data stream, and supplies them to the controller 405. Examples of the coding parameters that are required by the MPEG standard to be superimposed in the stream include picture type, motion vector, prediction mode, DCT mode, quantization scale code, quantization table information, etc. Basically, they are the parameters produced during the encoding process for generating the encoded stream.

A unique feature of this embodiment is that the variable-length decoding circuit 402 extracts the information described as MPEG\_ES\_Editing\_information() in the user data area of elementary streams in addition to the coding parameters specified by the MPEG standard as described above. Specifically, information about V-phase() and H-phase() is described as MPEG\_ES\_Editing\_information()



in the user data area in the sequence layer of encoded streams, and information about Time\_code(), Picture\_order(), Ancillary\_data(), and History\_data() is described as MPEG\_ES\_Editing\_information() in the user data area in the picture layer of encoded streams. The variable-length encoding circuit 402 extracts the information about V-phase(), H-phase(), Time\_code(), Picture\_order(), Ancillary\_data(), and History\_data() from the streams and supplies it to the controller 405.

The inverse quantizing circuit 403 inverse-quantizes the DCT coefficient data supplied by the variable-length decoding circuit 402 after variable-length decoding, based on the quantization scale supplied also by the variable-length decoding circuit 402 and supplies it to the inverse DCT circuit 404.

The inverse DCT circuit 404 performs an inverse DCT (discrete cosine transform) process on the quantized DCT coefficient supplied by the inverse quantizing circuit 403 and supplies it as image data subjected to inverse DCT to the arithmetic unit 411.

If the image data supplied to the arithmetic unit 411 by the inverse DCT circuit 404 is an I-picture, it is output from the arithmetic unit 411, supplied to the forward predictive picture section of the frame memory 414, and stored there for use to generate predictive picture data of the image data (P-picture or B-picture data) to be input later into the arithmetic unit 411.

If the image data supplied by the inverse DCT circuit 404 is P-picture data that uses the image data of the immediately preceding

frame as predictive picture data and if it is data in forward prediction mode, the image data (I-picture data) of the immediately preceding frame is read out from the forward predictive picture section of the frame memory 414 and subjected to motion compensation in the motion compensating circuit 412 corresponding to the motion vector output from the variable-length decoding circuit 402. Then the P-picture data is output after the image data (differential data) supplied by the inverse DCT circuit 404 is added to it in the arithmetic unit 411. The sum data, i.e., the decoded P-picture is supplied to the backward predictive picture section of the frame memory 413, and stored there for use to generate predictive picture data of the image data (B-picture or P-picture data) to be input later into the arithmetic unit 411.

Intra-picture prediction mode data is not processed in the arithmetic unit 411 and stored as it is in the backward predictive picture section 413 as is the case with I-picture data even if it is P-picture data.

Since this P-picture is to be displayed after the B-picture that follows, it is not output to a format conversion circuit 32 at this time (as described above, the P-picture input later than the B-picture is processed and transmitted before the B-picture).

If the image data supplied by the inverse DCT circuit 404 is B-picture data, the image data of the I-picture stored in the forward predictive picture section of the frame memory 414 (in the case of forward prediction mode), image data of the P-picture stored in the backward predictive picture section 413 (in the case of backward

prediction mode), or both image data (in the case of bidirectional backward prediction mode) are read out according to the prediction mode supplied from the variable-length decoding circuit 402. The image data is then subjected to motion compensation in the motion compensating circuit 412 according to the motion vector output from the variable-length decoding circuit 402, to generate a predictive picture. However, no predictive picture is generated if no motion compensation is necessary (in the case of intra-picture prediction mode).

The data that has thus been subjected to motion compensation by the motion compensating circuit 412 has the output from the inverse DCT circuit 404 added to it in the arithmetic unit 411. The sum output is supplied to the base-band video generation circuit 416 via the buffer 415. The video data output from this send buffer 415 contains only the video data for the active video area, but is not provided with ancillary data for the blanking interval or the like.

The controller 405 controls the operation of the circuits described above, based on the information about picture type, motion vector, prediction mode, DCT mode, quantization scale, quantization table information, and other coding parameters supplied by the variable-length decoding circuit 402.

Furthermore, the controller 405 controls the base-band video generation circuit 416, based on the V-phase and H-phase information supplied from the variable-length decoding circuit 402 as MPEG\_ES\_Editing\_information(). The V-phase extracted from the encoded stream represents the vertical position of the active video

area in the full pixel area of the input video data while the H-phase represents the horizontal position of the active video area in the full pixel area of the input video data. Therefore, the controller 405 controls the base-band video generation circuit, in such a way that the decoded video data output from the buffer 415 will be mapped to the vertical and horizontal positions represented by V-phase and H-phase, on the full pixel area with the blanking image, or in such a way as to synthesize the decoded video data in the active area and blanking image in the full pixel area based on the vertical and horizontal positions represented by V-phase and H-phase. Consequently, the video data output from the base-band video generation circuit 416 has exactly the same blanking interval as the blanking interval in the input video data supplied to the MPEG encoder.

The controller 405 supplies Ancillary\_data, Line\_number, Field\_ID, Time\_code\_1, and Time\_code\_2 extracted from the encoded stream or controls the multiplexing process of the multiplexing circuit 417 for Ancillary\_data, Time\_code\_1, and Time\_code\_2, based on Field\_ID. Specifically, as described with reference to Figure 7C, since Field\_ID is associated with Ancillary\_data assigned to each field, the multiplexing circuit 417 superimposes Ancillary\_data associated with Field\_ID during the blanking interval identified by Field\_ID. For example, if Field\_ID is "2," it can be seen that this is the third field in the frame. Thus, in the encoded stream, Ancillary\_data received as ancillary data associated with Field\_ID of "2" is superimposed on the blanking interval of the third field with Field\_ID of "2." When

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superimposing Ancillary\_data on the blanking interval, the multiplexing circuit 417 superimposes Ancillary\_data at the line number specified by Line\_number transmitted with Ancillary\_data.

Therefore, the video data output from the multiplexing circuit 417 has exactly the same ancillary data at exactly the same line number, in the active video area of exactly the same location, in exactly the same blanking interval as the input video data supplied to the MPEG encoder.

Thus, according to this embodiment, any MPEG encoding or decoding performed during the transmission of video data from the sending system to the receiving system will not cause the information inherent to the input video data or the ancillary data added to the input video data to be lost.

#### Industrial Applicability

The present invention can be used at broadcasting stations and the like where video data is encoded and decoded frequently.

## CLAIMS

1. An encoding system for encoding input video data, characterized by comprising:

encoding means for encoding said input video data to generate an elementary stream and describing, in said elementary stream, information about the picture order of said elementary stream; and

generation means for receiving said elementary stream and generating time stamp information about said elementary stream from said picture order information described in said elementary stream.

2. The encoding system according to claim 1, characterized in that said encoding means describes said picture order information in the picture layer of said elementary stream.

3. The encoding system according to claim 1, characterized in that said picture order information is described as `Picture_order()` in the picture layer of said elementary stream.

4. The encoding system according to claim 1, characterized in that:  
said picture order information is inserted into the picture layer of said elementary stream; and

said generation means extracts said picture order information from said elementary stream by parsing the syntax of said elementary stream.

5. The encoding system according to claim 1, characterized in that said time stamp information contains presentation time stamps and/or decoding time stamps.

6. The encoding system according to claim 1, characterized in that said generation means comprises means for generating a packetized elementary stream by packetizing said elementary stream and adds said time stamp information to the header of said packetized elementary stream.

7. The encoding system according to claim 1, characterized in that said generation means comprises means for generating a packetized elementary stream by packetizing said elementary stream and uses said time stamp information to add said time stamp information as the header of said packetized elementary stream.

8. The encoding system according to claim 1, characterized in that:  
said time stamp information contains presentation time stamps and/or decoding time stamps; and

said generation means generates a packetized elementary stream by packetizing said elementary stream and adds said presentation time stamps and/or decoding time stamps as the header of said packetized elementary stream.

9. The encoding system according to claim 1, characterized in that said picture order information is generated by counting the fields in said input video data.

10. The encoding system according to claim 1, in which said input video data has a 30-Hz frame frequency generated by a 3:2 pull-down process performed on source video data with a 24-Hz frame frequency, further comprising:

counting means for counting the fields in the input video data with said 30-Hz frame frequency; and

2:3 pull-down means, connected between said counting means and said encoding means, for performing the 2:3 pull-down process to convert the input video data with said 30-Hz frame frequency into video data with a 24-Hz frame frequency,

characterized in that said encoding means generates said time stamp information, based on the count information from said counting means.

11. An encoding system for encoding input video data, characterized by comprising:

encoding means for encoding said input video data to generate an elementary stream and describing, in said elementary stream, information about the picture order of said elementary stream; and

a packetizer for packetizing said elementary stream, based on said picture order information described in said elementary stream.



12. An encoding system for encoding input video data, characterized by comprising:

encoding means for generating an elementary stream by encoding said input video data in which the information used to generate presentation time stamps has been described in said elementary stream; and

a packetizer for packetizing said elementary stream, based on the information used to generate said presentation time stamps described in said elementary stream.

13. An encoding system for encoding input video data, characterized by comprising:

encoding means for encoding said input video data to generate an elementary stream and describing, in said elementary stream, information about the picture order of said elementary stream; and

a packetizer for packetizing said elementary stream, based on said picture order information described in said elementary stream.

14. An encoding system for encoding input video data, characterized by comprising:

encoding means for generating an elementary stream by encoding said input video data and for multiplexing, in the elementary stream, time stamp information about the decoding and/or presentation of said elementary stream; and

processing means for receiving said elementary stream and for performing stream processing for said elementary stream, based on said time stamp information described in said elementary stream.

15. An encoding system for encoding a plurality of input video data, characterized by comprising:

encoding means for encoding said plurality of input video data to generate a plurality of elementary streams and describing, in each of said elementary streams, time stamp information about the decoding and/or presentation of said elementary streams; and

multiplexing means for receiving said plurality of elementary streams and multiplexing said plurality of elementary streams, based on said time stamp information added in said each elementary stream.

16. An encoding system for encoding input video data, comprising:

an encoder for encoding said input video data to generate an elementary stream; and

a packetizer for generating a packetized elementary stream from said elementary stream,

characterized in that said encoder describes in said elementary stream the information needed to generate the time stamp to be described in the header of said packetized elementary stream.

17. An encoding system for encoding input video data, comprising:

an encoder for encoding said input video data to generate an elementary stream; and

a packetizer for generating a packetized elementary stream from said elementary stream,

characterized in that said encoder transmitting the information used to generate the time stamp to be described in the header of said packetized elementary stream to said packetizer.

18. An encoding method for encoding input video data, characterized by comprising the steps of:

encoding said input video data to generate an elementary stream and describing, in said elementary stream, information about the picture order of said elementary stream; and

packetizing said elementary stream, based on said picture order information described in said elementary stream.

19. An encoding method for encoding input video data, characterized by comprising the steps of:

generating an elementary stream by encoding said input video data wherein the information used to generate presentation time stamps has been described in said elementary stream; and

packetizing said elementary stream, based on the information used to generate said presentation time stamps described in said elementary stream.

20. An encoding method for encoding input video data, characterized by comprising the steps of:

encoding said input video data to generate an elementary stream and multiplexing, in said elementary stream, time stamp information about the decoding and/or presentation of said elementary stream; and

receiving said elementary stream and performing stream processing for said elementary stream, based on said time stamp information described in said elementary stream.

21. An encoding method for encoding a plurality of input video data, characterized by comprising the steps of:

encoding said plurality of input video data to generate a plurality of elementary streams and describing, in each of said elementary streams, time stamp information about the decoding and/or presentation of said elementary streams; and

receiving said plurality of elementary streams and multiplexing said plurality of elementary streams, based on said time stamp information added in said each elementary stream.

22. An encoding method for encoding input video data, comprising:

an encoding step for encoding said input video data to generate an elementary stream; and

a step for generating a packetized elementary stream from said elementary stream,

characterized in that said encoding step involves describing in said elementary stream the information needed to generate the time stamp to be described in the header of said packetizer.

23. An encoding method for encoding input video data, characterized by comprising the steps of:

encoding said input video data to generate an elementary stream;  
transmitting the information used to generate said elementary stream and time stamps; and

generating a packetized elementary stream from said elementary stream based on the method.

24. An encoding method for encoding a plurality of input video data, characterized by comprising the steps of:

generating a plurality of elementary streams by encoding said plurality of input video data;

describing, in each of said elementary streams, time stamp information about the decoding and/or presentation of said elementary streams; and

receiving said plurality of elementary streams and multiplexing said plurality of elementary streams, based on said time stamp information added in said each elementary stream.

25. A multiplexing apparatus for multiplexing the plurality of elementary streams generated by encoding a plurality of input video data, characterized by comprising:

means for extracting the time stamp information associated with each of the plurality of elementary streams from said plurality of elementary streams; and

means for multiplexing said plurality of elementary streams, based on said time stamp information extracted from said each elementary stream.

26. A multiplexing method for multiplexing the plurality of elementary streams generated by encoding a plurality of input video data, characterized by comprising the steps of:

extracting the time stamp information associated with each of said plurality of elementary streams from said plurality of elementary streams and

multiplexing said plurality of elementary streams, based on said time stamp information extracted from said each elementary stream.

27. A decoding system for decoding the encoded stream generated by encoding source video data, comprising:

means for extracting the decoding time stamps contained in said encoded stream; and

means for decoding the encoded stream based on said decoding time stamps,

characterized in that said decoding time stamps are information generated based on the number of fields in said source video data.

28. A decoding method for decoding the encoded stream generated by encoding source video data, comprising the steps of:

extracting the decoding time stamps contained in said encoded stream; and

decoding the encoded stream based on said decoding time stamps, characterized in that said decoding time stamps are information generated based on the number of fields in said source video data.

29. A display system for generating decoded video data by decoding the encoded stream generated by encoding source video data and for displaying said decoded video data, comprising:

means for extracting the presentation time stamps contained in said encoded stream;

means for decoding said encoded stream to generate decoded video data; and

means for displaying said decoded video data based on said presentation time stamps,

characterized in that said presentation time stamps are information generated based on the number of fields in said source video data.

30. A display method for generating decoded video data by decoding the encoded stream generated by encoding source video data and for displaying said decoded video data, comprising the steps of:

extracting the presentation time stamps contained in said encoded stream;

decoding said encoded stream to generate decoded video data; and

displaying said decoded video data based on said presentation time stamps,

characterized in that said presentation time stamps contained in said encoded stream are information generated based on the number of fields in said source video data.



## ABSTRACT

The present invention relates to an encoding system for encoding input video data and a multiplexing system for multiplexing a plurality of encoded streams. More particularly, it proposes a system and method that involve describing, in encoded streams, information on the picture order of input video data, and using the picture order information when generating packetized elementary stream (PES) packets, to prevent delays associated with the PES packet generation.

MPEG encoders generate PTS\_count and DTS\_count based on the information obtained from the number of fields in the input video data and describe the PTS\_count and DTS\_count data as picture order information in encoded streams. The packetizers for generating packetized elementary stream take out PTS\_count and DTS\_count described in the encoded streams, generate presentation time stamps and decoding time stamps based on PTS\_count and DTS\_count, and add these time stamps as PES header data.

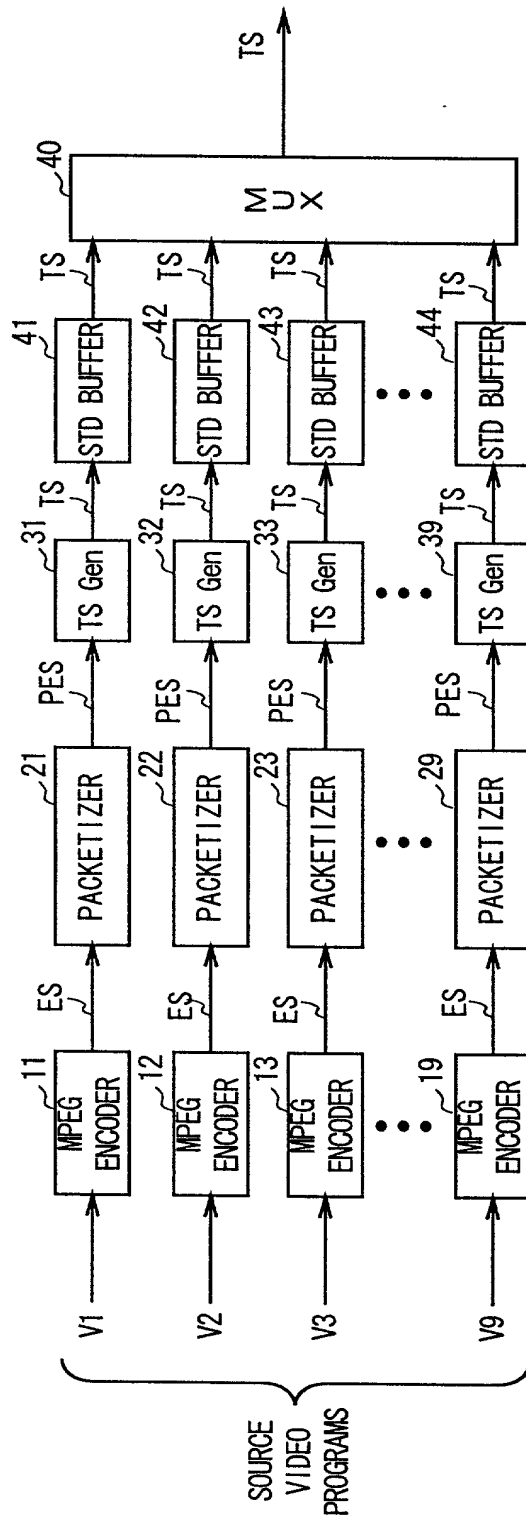


FIG. 1

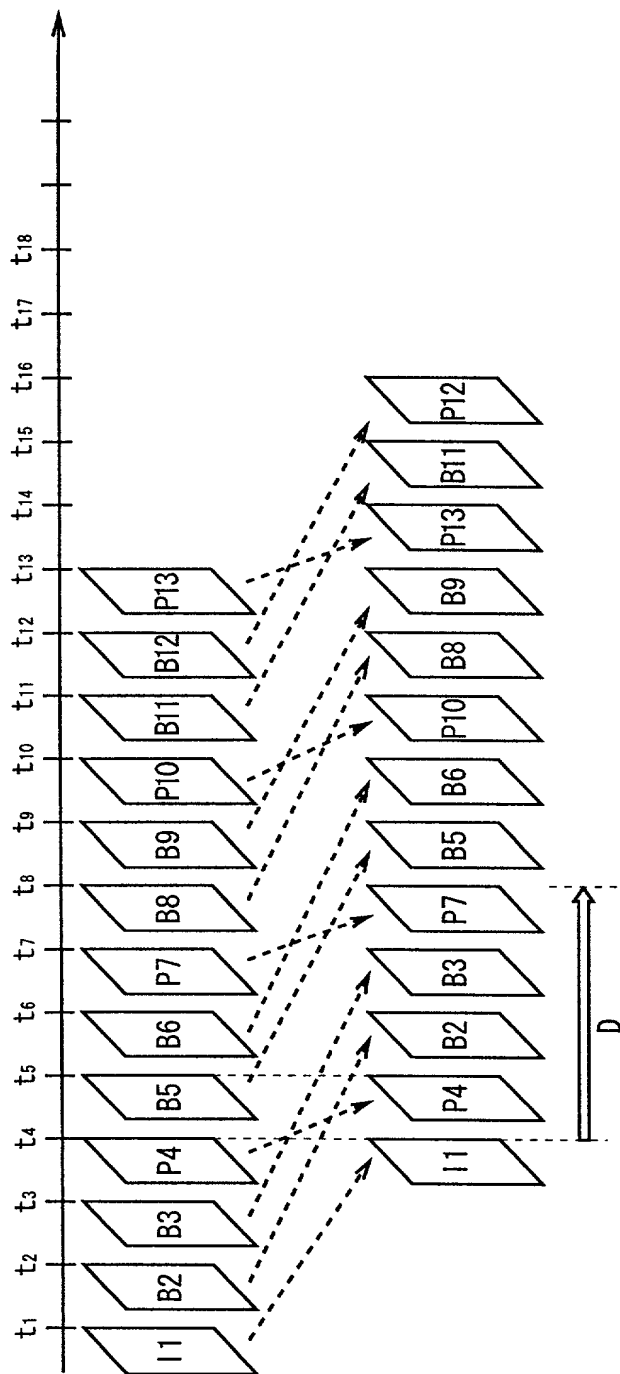


FIG. 2A

FIG. 2B ES

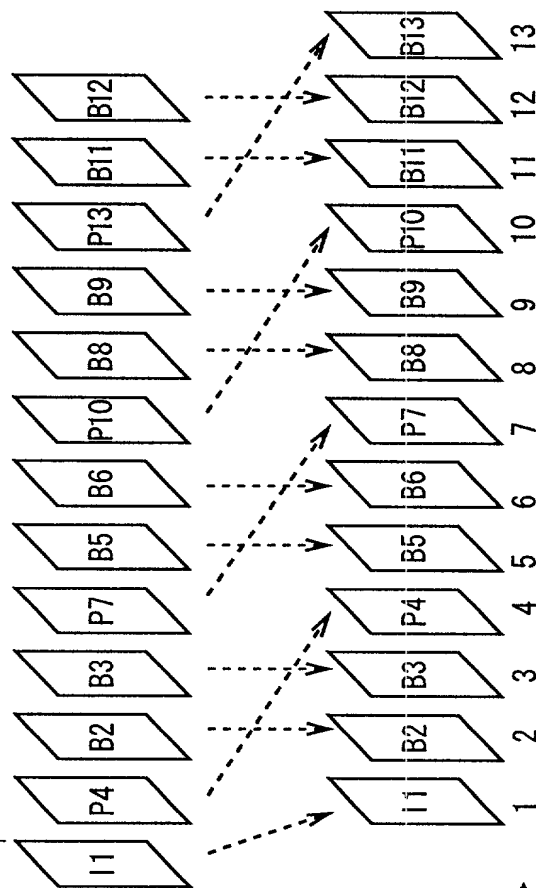


FIG. 2C

FIG. 2D DECODED VIDEO (PRESENTATION VIDEO)



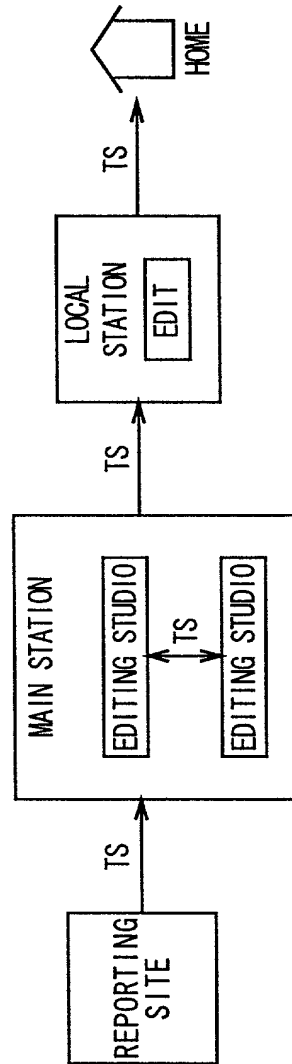


FIG. 3

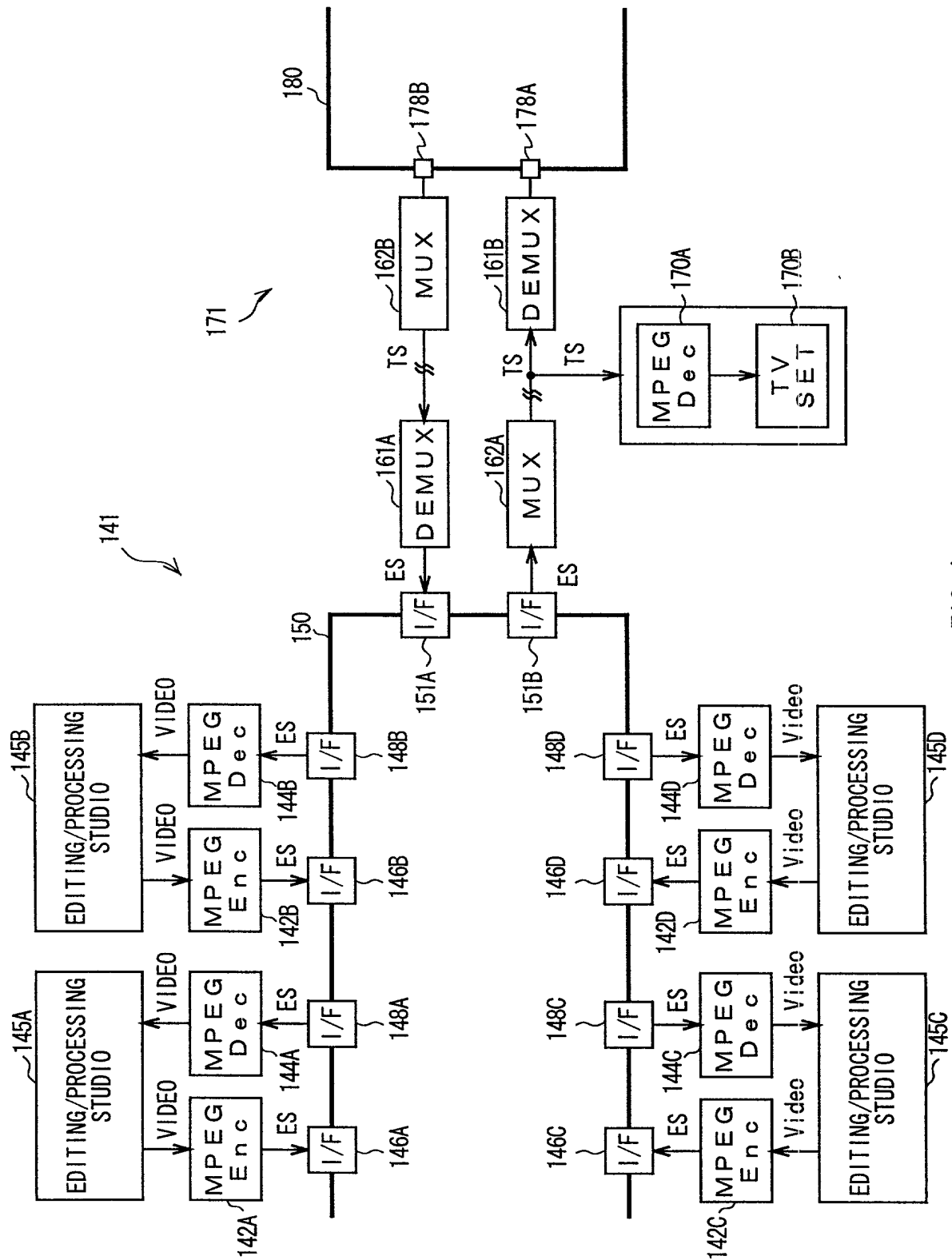
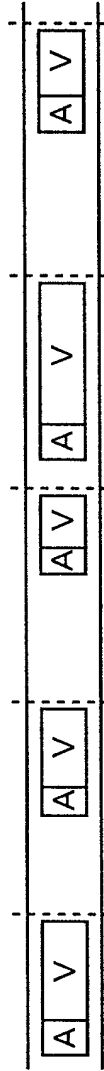


FIG. 4

FIG. 5A



SDT-CP: ELEMENTARY STREAM WITHIN BROADCASTING STATION

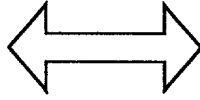


FIG. 5B



MPEG: TRANSPORT STREAM BETWEEN BROADCASTING STATIONS

007207 02924950

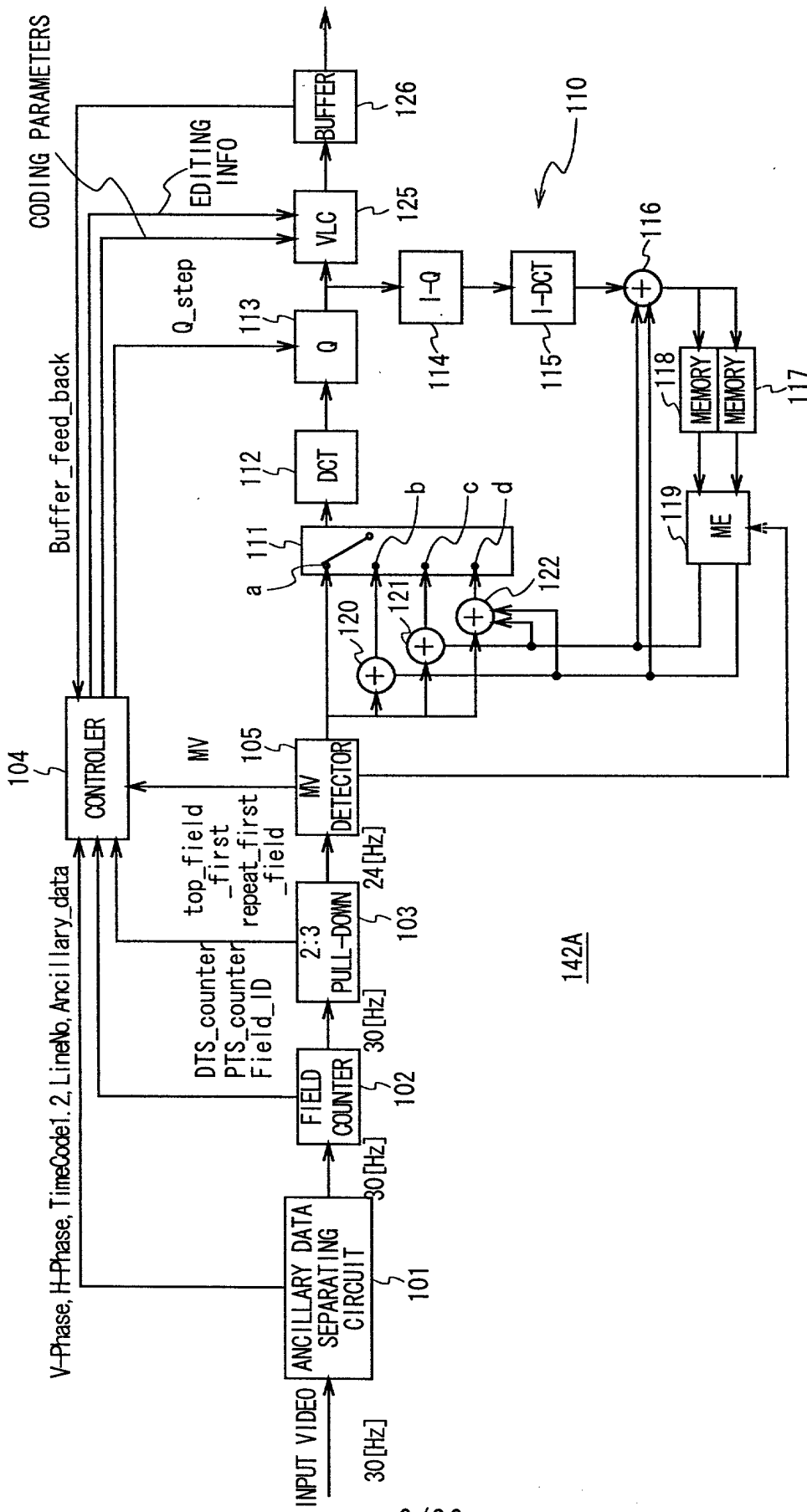


FIG. 6

VIDEO DATA  
SUBJECTED TO  
3:2 PULL-DOWN  
30 [Hz]

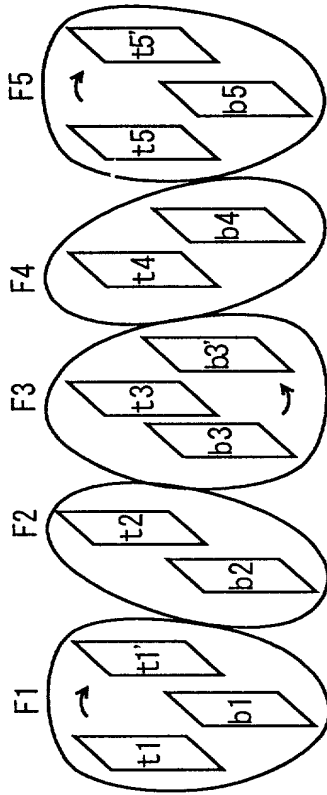


FIG. 7A

VIDEO DATA  
SUBJECTED TO  
2:3 PULL-DOWN

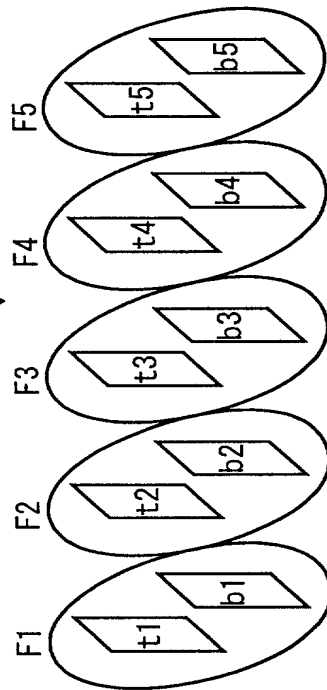


FIG. 7B

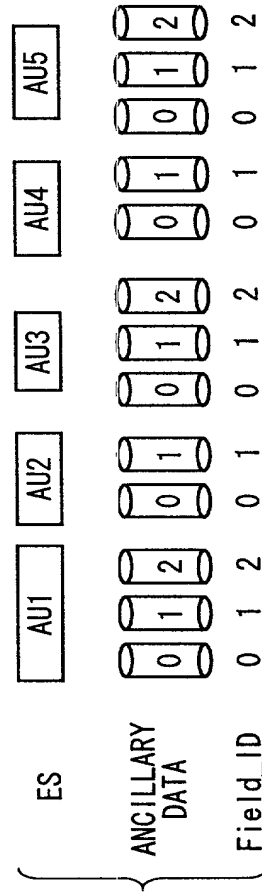


FIG. 7C



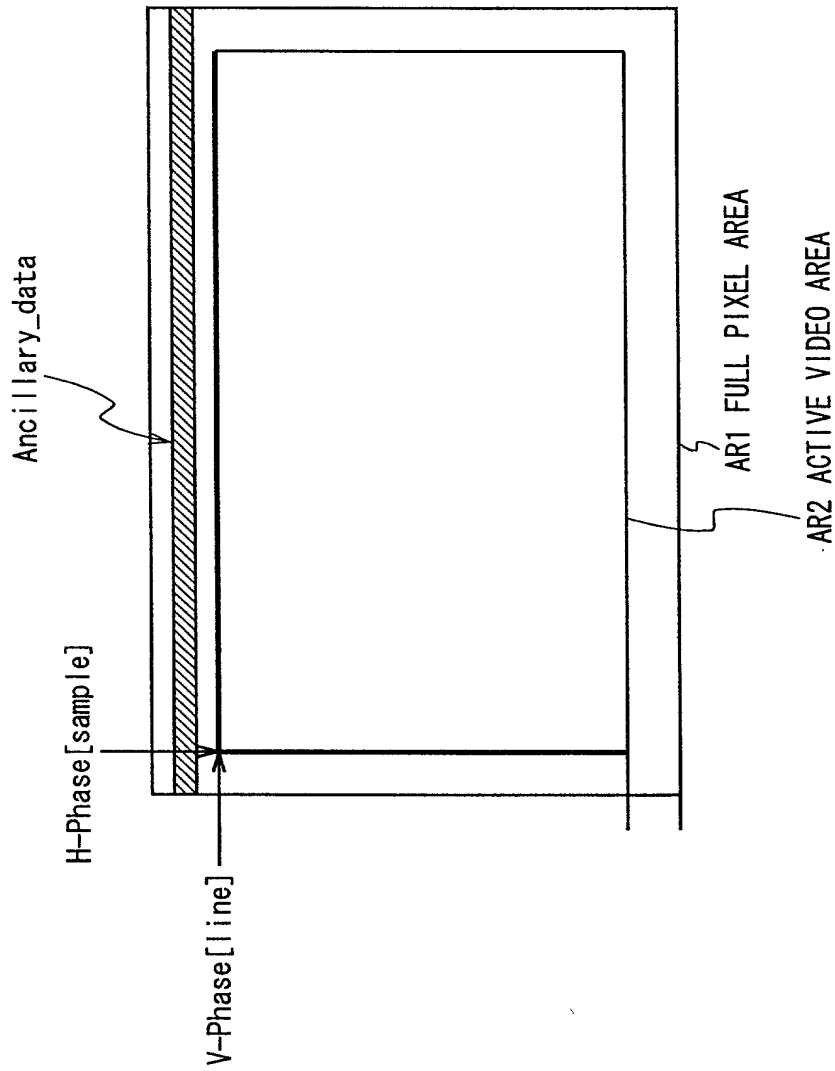


FIG. 8

FIG. 9A

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13
FRAME NO	1	2	3	4	5	6	7	8	9	10	11	12	13
PICTURE TYPE	I	B	B	P	B	B	P	B	B	I	B	B	P
Repeat_first_field	1	0	1	0	1	0	1	0	1	0	1	0	1
Top_field_first	1	0	0	1	1	0	0	1	1	0	0	1	1
FRAME STRUCTURE	I	I	I	I	I	I	I	I	I	I	I	I	I

FIG. 9B

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13
FRAME NO	1	2	3	4	5	6	7	8	9	10	11	12	13
PICTURE TYPE	I	B	B	P	B	B	P	B	B	I	B	B	P
Repeat_first_field	1	0	1	0	1	0	1	0	1	0	1	0	1
Top_field_first	1	0	0	1	1	0	0	1	1	0	0	1	1
FRAME STRUCTURE	I	I	I	I	I	I	I	I	I	I	I	I	I
PTS_counter	0	3	5	8	10	13	15	18	20	23	25	28	30

FIG. 9C

	F1	F4	F2	F3	F7	F5	F6	F10	F8	F9	F13	F11	F12
FRAME NO	1	4	2	3	7	5	6	10	8	9	13	11	12
PICTURE TYPE	I	P	B	B	P	B	B	I	B	B	P	B	B
Repeat_first_field	1	0	0	1	1	1	0	0	0	1	1	1	0
Top_field_first	1	1	0	0	0	1	0	0	1	1	1	0	1
FRAME STRUCTURE	I	I	I	I	I	I	I	I	I	I	I	I	I
DTS_counter	125	0	3	5	8	10	13	15	18	20	23	25	28

video_sequence(){	No. of bits	Mnemonic
next_start_code()		
sequence_header()		
sequence_extension()		
do{		
extension_and_user_data(0)		
do{		
if(nextbits()==group_start_code){		
group_of_pictures_header()		
extension_and_user_data(1)		
}		
picture_header()		
picture_coding_extension()		
extension_and_user_data(2)		
picture_data()		
}while((nextbits()==picture_start_code)		
(nextbits()==group_start_code))		
if(nextbits()!=sequence_end_code){		
sequence_header()		
sequence_extension()		
}		
}while(nextbits()!=sequence_end_code)		
sequence_end_code	32	bslbf
}		

FIG. 10

sequence_header(){	No. of bits	Mnemonic
sequence_header_code	32	bslbf
horizontal_size_value	12	uimbsf
vertical_size_value	12	uimbsf
aspect_ratio_information	4	uimbsf
frame_rate_code	4	uimbsf
bit_rate_value	18	uimbsf
marker_bit	1	"1"
vbv_buffer_size_value	10	uimbsf
constrained_parameters_flag	1	
load_intra_quantiser_matrix	1	
if(load_intra_quantiser_matrix)		
intra_quantiser_matrix [64]	8*64	uimbsf
load_non_intra_quantiser_matrix	1	
if(load_non_intra_quantiser_matrix)		
non_intra_quantiser_matrix [64]	8*64	uimbsf
next_start_code()		
}		

FIG. 11

picture_data(){	No. of bits	Mnemonic
do{		
slice()		
}while(nextbits()--slice_start_code)		
next_start_code()		
}		

FIG. 25

sequence_extention(){	No. of bits	Mnemonic
extension_start_code	32	bslbf
extension_start_code_identifier	4	ulmsbf
profile_and_level_indication	8	uimsbf
progressive_sequence	1	uimsbf
chroma_format	2	ulmsbf
horizontal_size_extension	2	uimsbf
vertical_size_extension	2	ulmsbf
blt_rate_extension	12	ulmsbf
marker_blt	1	bslbf
vbv_buffer_size_extension	8	ulmsbf
low_delay	1	uimsbf
frame_rate_extension_n	2	unimsbf
frame_rate_extension_d	5	ulmsbf
next_start_code()		
}		

FIG. 12

extension_and_user_data(i){	No. of bits	Mnemonic
while((i!=1)&&(nextbits()=extension_start_code)) {		
(nextbits()=user_data_start_code){		
if(nextbits()=extension_start_code)		
extension_data(i)		
if(nextbits()=user_data_start_code)		
user_data()		
}		
}		

FIG. 13

Syntax	Bits	Mnemonic
user_data() {		
user_data_start_code	32	
MPEG_ES_Editing_Information(i) {		
if(i==0) {		
while(nextbits() != "0000 0000 0000 0000 0000 0001" ) {		
if(nextbits() == "V-phase" )		
V-phase()		
Else if(nextbits() == "H-phase" )		
H-phase()		
{		
{		
Else if(i==2) {		
while(nextbits() != "0000 0000 0000 0000 0000 0001" ) {		
if((nextbits() == "Time code1" )    (nextbits() == "Time code2" ))		
Time_code()		
Else if(nextbits() == "Picture Order" )		
Picture_order()		
{		
while(nextbits() != "0000 0000 0000 0000 0000 0001" ) {		
if(nextbits() == "Ancillary_data" )		
Ancillary_data()		
Else if(nextbits() == "History data" )		
History_data()		
{		
{		
if(nextbits() == "User data" )		
User_data()		
Next_start_code()		
}		
}		
}		
}		
}		

FIG. 14

Data_ID	Data_type
00	FORBIDDEN
01	V-Phase
02	H-Phase
03	Time code 1
04	Time code 2
05	Picture Order
06	Video Index
07	Ancillary data
08	History data
...	...
80	Control flags
...	...
FF	User data

FIG. 15

Syntax	Bits	Mnemonic
V-Phase(){		
Data_ID	8	bslbf
V-Phase	16	uimsbf
}		

FIG. 16

Syntax	Bits	Mnemonic
H-Phase(){		
Data_ID	8	bslbf
H-Phase	8	uimsbf
}		

FIG. 17

Syntax	Bits	Mnemonic
Picture_order(){		
Data_ID	8	bslbf
DTS_presence	1	bslbf
PTS_counter	7	uimsbf
If(DTS_presence== "1" ){		
Marker_bits	1	bslbf
DTS_counter	7	uimsbf
}		
}		

FIG. 20



Syntax	Bits	Mnemonic
Time_code(){		
Data_ID	8	bslbf
Time_code [63..48]	16	uimsbf
Marker_bit	1	bslbf
Time_code [47..32]	16	uimsbf
Marker_bit	1	bslbf
Time_code [31..16]	16	uimsbf
Marker_bit	1	bslbf
Time_code [15..0]	16	uimsbf
Marker_bit	1	bslbf
Reserved_bits	4	bslbf
}		

FIG. 18

Syntax	Bits	Mnemonic
Time_code [63..0]{		
Color frame flag	1	bslbf
Drop frame flag (NTSC)/unused (PAL)	1	bslbf
TV frame tens	2	uimsbf
TV frame units	4	uimsbf
Field phase (NTSC)/binary group flag 0 (PAL)	1	bslbf
TV seconds tens	3	uimsbf
TV seconds units	4	uimsbf
Binary group flag 0 (NTSC)/binary group flag 2 (PAL)	1	bslbf
TV minutes tens	3	uimsbf
TV minutes units	4	uimsbf
Binary group flag 2 (NTSC)/field phase (PAL)	1	bslbf
Binary group flag 1 (NTSC)/binary group flag 1 (PAL)	1	bslbf
TV hours tens	2	uimsbf
TV hours units	4	uimsbf
2nd binary group	4	uimsbf
1st binary group	4	uimsbf
4th binary group	4	uimsbf
3rd binary group	4	uimsbf
6th binary group	4	uimsbf
5th binary group	4	uimsbf
8th binary group	4	uimsbf
7th binary group	4	uimsbf
}	4	uimsbf

FIG. 19

Syntax	Bits	Mnemonic
Ancillary_data(){		
Data_ID	8	bslbf
Field_ID	2	bslbf
Line_number	14	uimsbf
Ancillary_data_length	16	uimsbf
Marker_bits	1	bslbf
For(j=0; j<Ancillary_data_length; j++){		
Ancillary_data_payload	22	uimsbf
Marker_bits	1	bslbf
}		
While(!bytealigned())		
Zero_bit	1	"0"
}		

FIG. 21

group_of_picture_header(){	No. of bits	Mnemonic
group_start_code	32	bslbf
time_code	25	bslbf
closed_gop	1	uimsbf
broken_link	1	uimsbf
next_start_code()		
}		

FIG. 22

picture_header(){	No. of bits	Mnemonic
picture_start_code	32	bslbf
temporal_reference	10	uimsbf
picture_coding_type	3	uimsbf
vbm_delay	16	uimsbf
if(picture_coding_type==2   picture_coding_type==3){		
full_pel_forward_vector	1	
forward_f_code	3	uimsbf
}		
if(picture_coding_type==3){		
full_pel_backward_vector	1	
backward_f_code	3	uimsbf
}		
while(nextbits()-- "1" ){		
extra_bit_picture/*with the value "1" */	1	uimsbf
extra_information_picture	8	
}		
extra_bit_picture/*with the value "0" */	1	uimsbf
next_start_code()		
}		

FIG. 23

picture_coding_extension(){	No. of bits	Mnemonic
extension_start_code	32	bslbf
extension_start_code_idenfier	4	uimsbf
f_code [0][0]/*forward horizontal*/	4	uimsbf
f_code [0][1]/*forward vertical*/	4	uimsbf
f_code [1][0]/*backward horizontal*/	4	uimsbf
f_code [1][1]/*backward vertical*/	4	uimsbf
intra_dc_precision	2	uimsbf
picture_structure	2	uimsbf
top_field_first	1	uimsbf
frame_pred_frame_dct	1	uimsbf
concealment_motion_vectors	1	uimsbf
q_scale_type	1	uimsbf
intra_vlc_format	1	uimsbf
alternate_scan	1	uimsbf
repeat_first_field	1	uimsbf
chroma_420_type	1	uimsbf
progressive_frame	1	uimsbf
composite_display_flag	1	uimsbf
if(composite_display_flag){		
v_axis	1	uimsbf
field_sequence	3	uimsbf
sub_carrier	1	uimsbf
burst_amplitude	7	uimsbf
sub_carrier_phase	8	uimsbf
}		
next_start_code()		
}		

FIG. 24

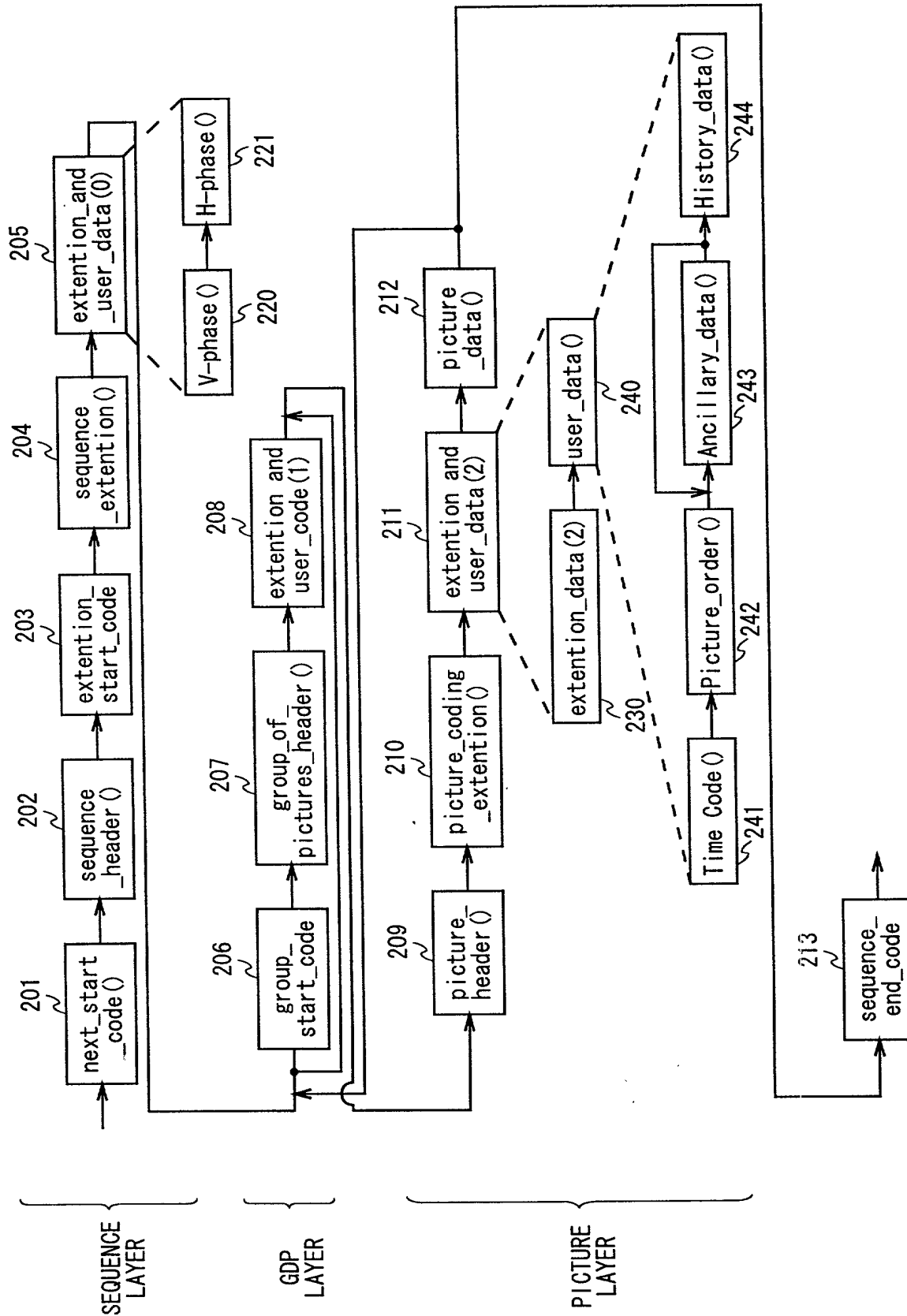


FIG. 26

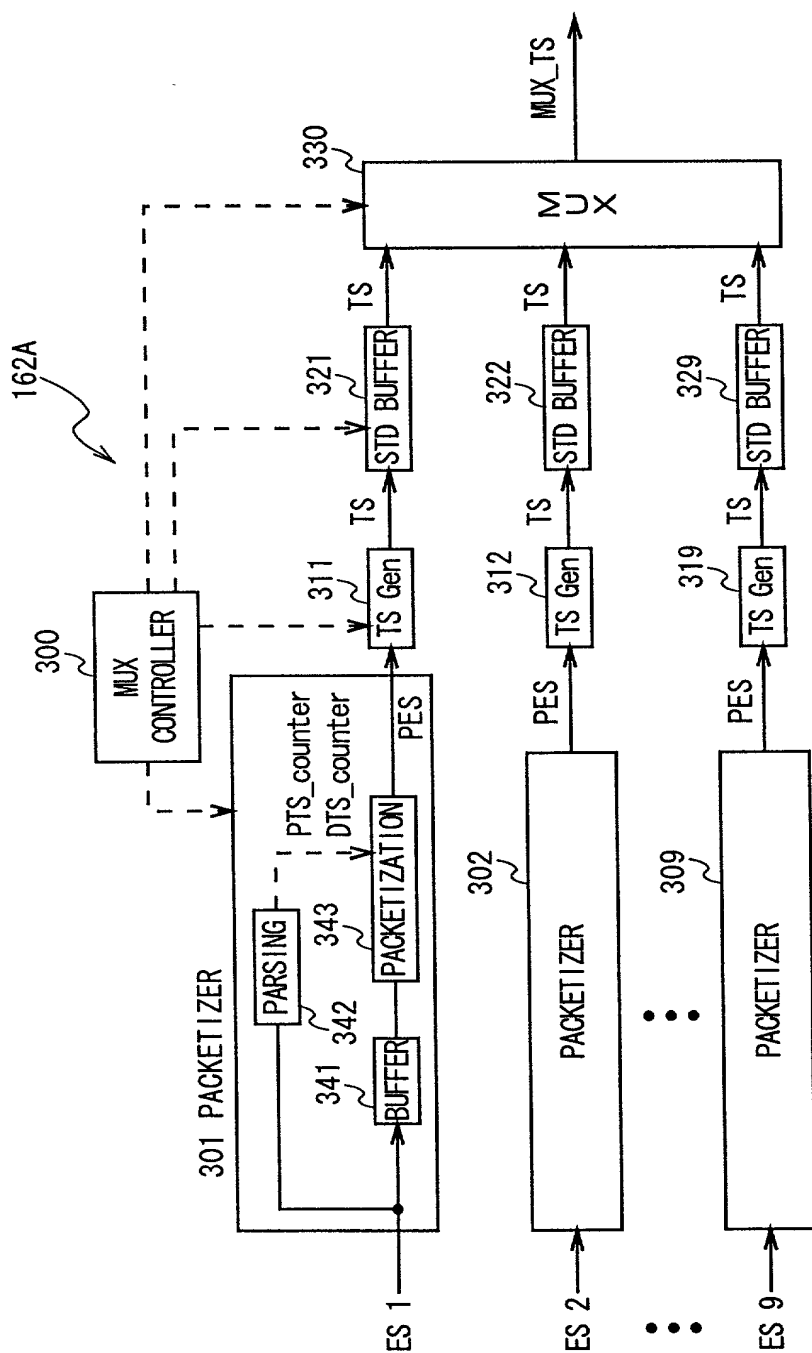


FIG. 27

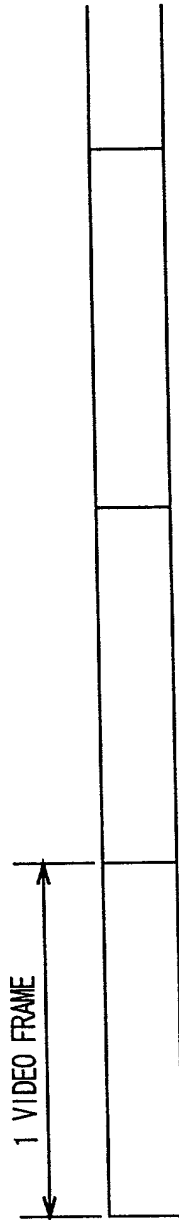


FIG. 28A SOURCE VIDEO DATA

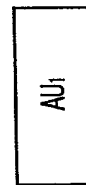


FIG. 28B ES (ELEMENTARY STREAM)

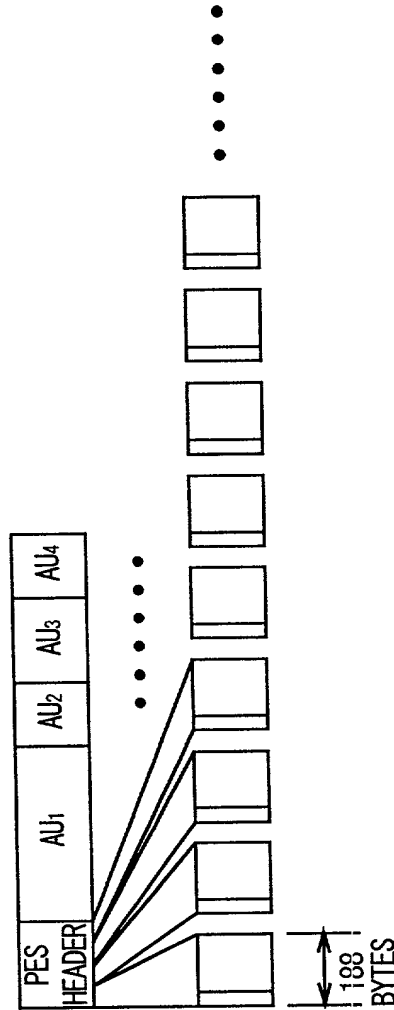


FIG. 28C PES PACKET

FIG. 28D TS PACKET

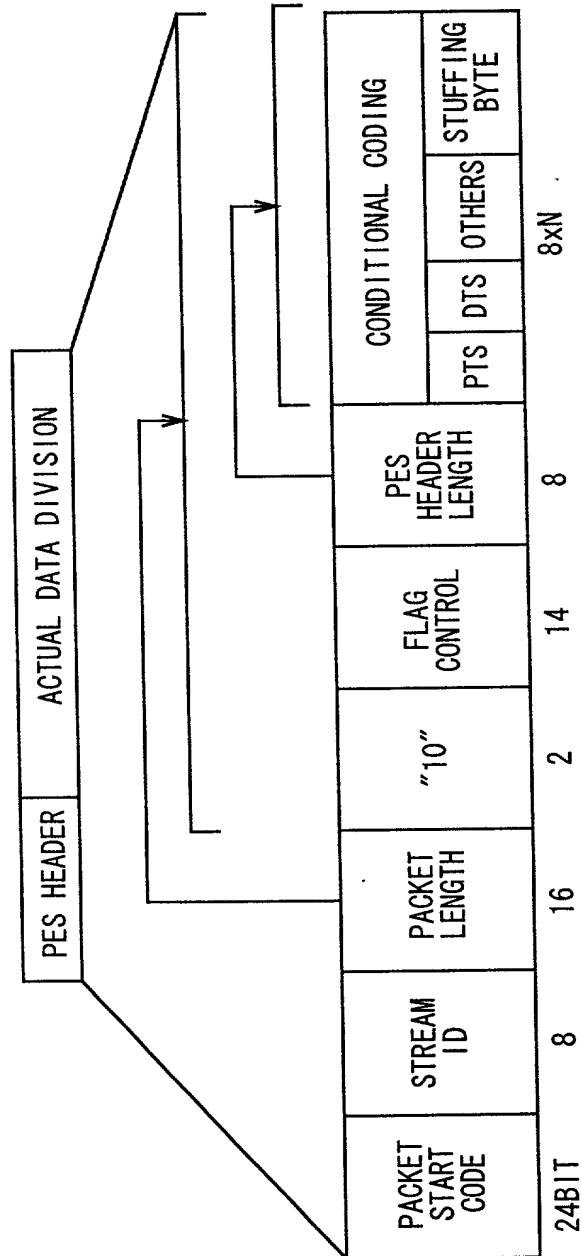


FIG. 29



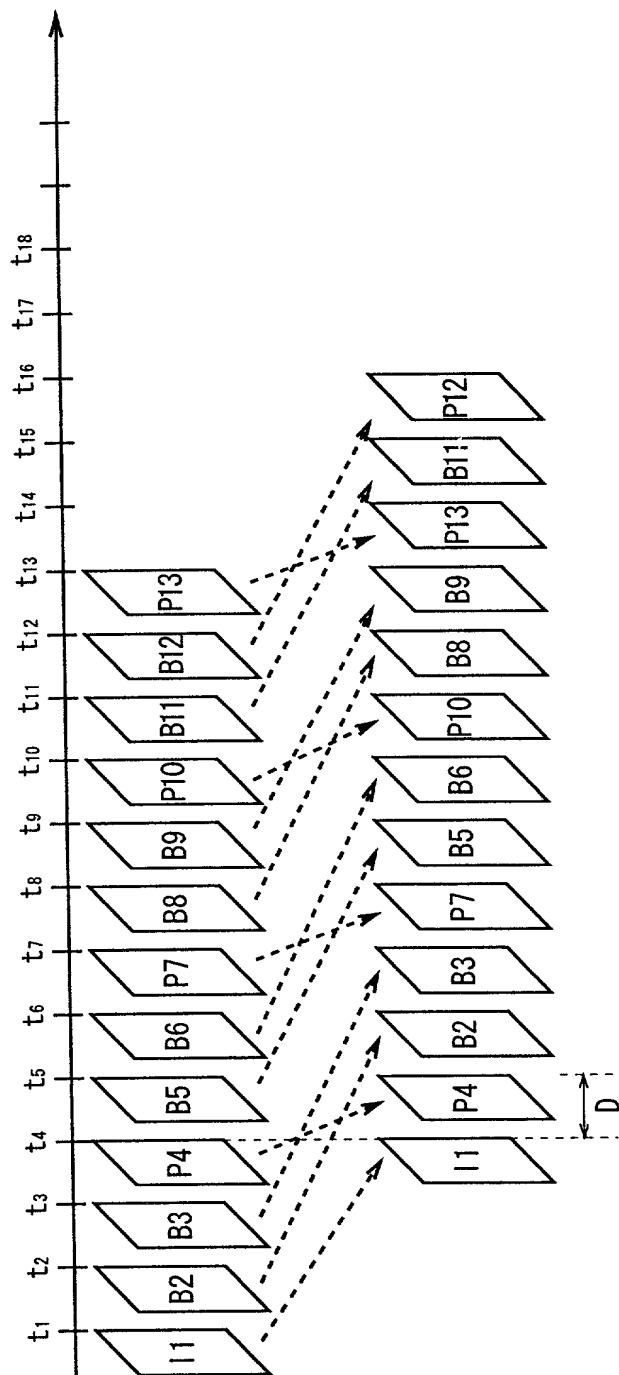


FIG. 30A SOURCE VIDEO

FIG. 30B ES

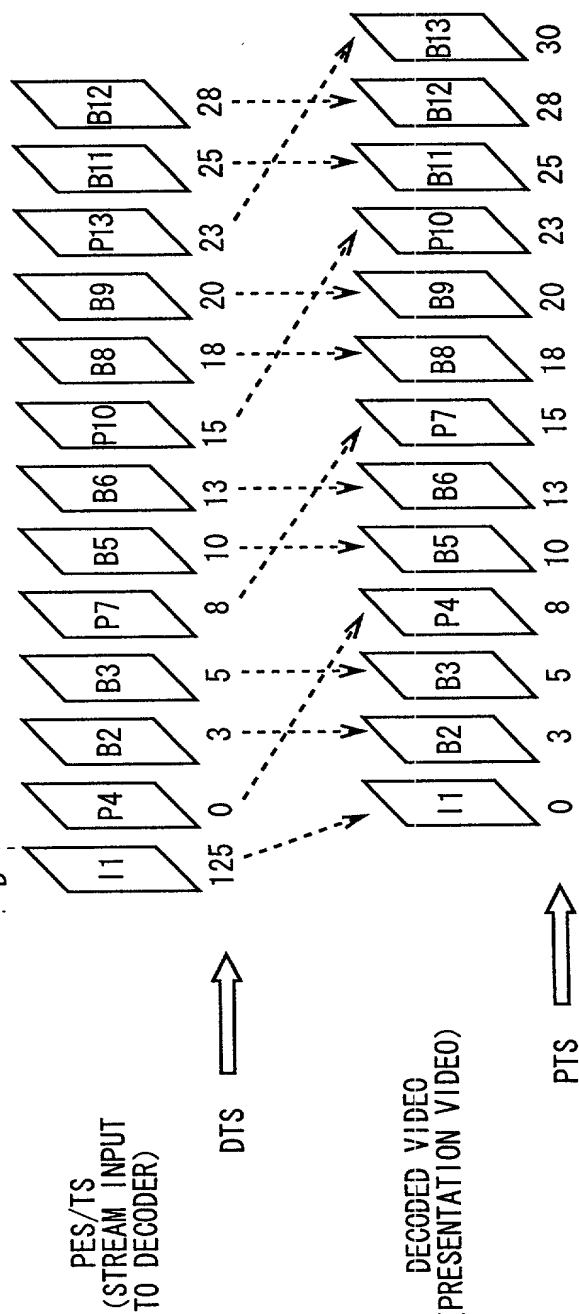
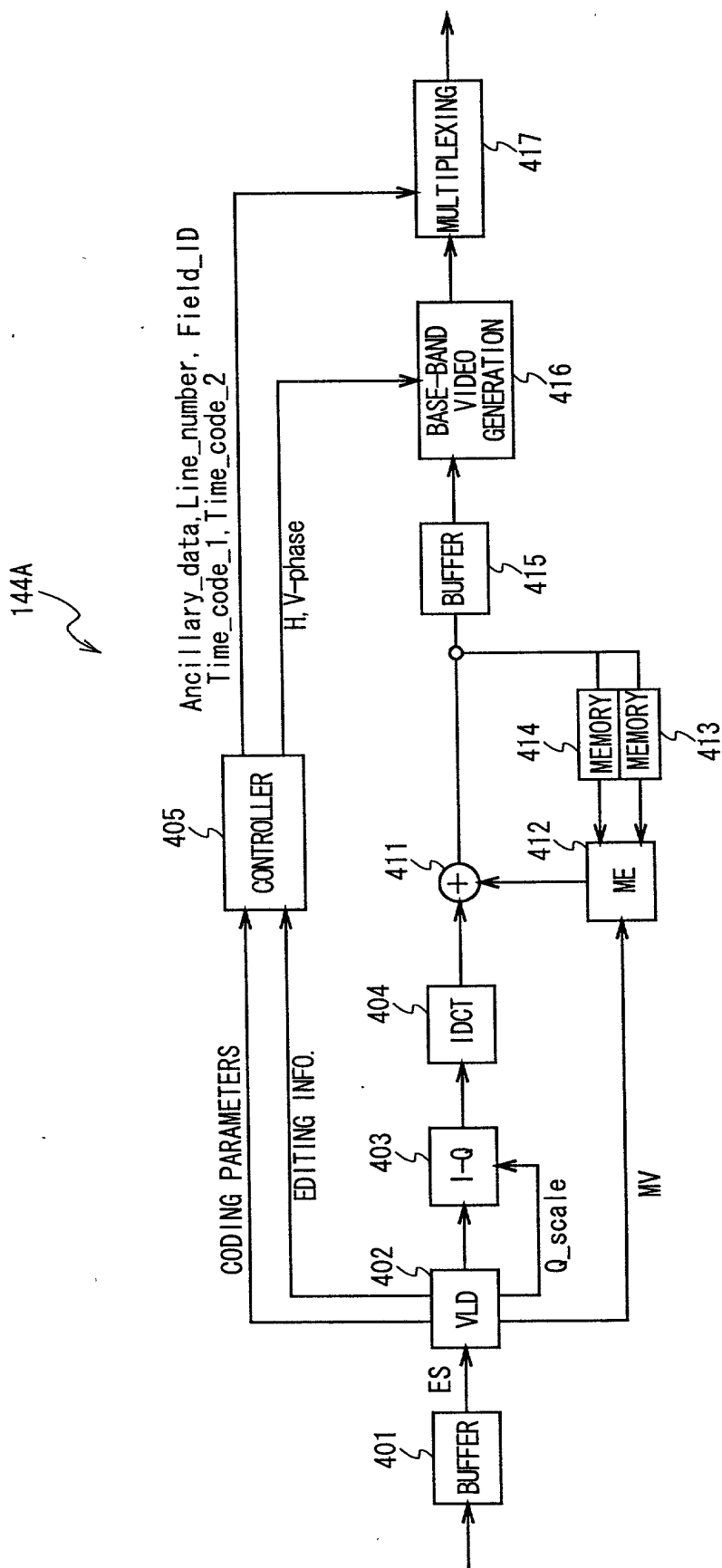


FIG. 30C PES/TS (STREAM INPUT TO DECODER)

FIG. 30D DECODED VIDEO (PRESENTATION VIDEO)



## Explanation of Reference Numerals

1 ... Video processor, 2 ... MPEG encoder, 3 ... MPEG decoder, 5 ... 3:2 pull-down process, 6 ... 2:3 pull-down process, 104 ... Controller, 105 ... motion vector detector, 112 ... DCT circuit, 113, ... Quantizing circuit, 119 ... Motion compensating circuit, 125 ... Variable-length coding circuit, 126 ... Send buffer, 142A ... MPEG encoder, 300 ... Multiplexing controller, 301, 302, 309 ... Packetizers, 330 ... Multiplexer.

## Declaration and Power of Attorney for Patent Application

## 特許出願宣言書及び委任状

## Japanese Language Declaration

## 日本語宣言書

私は、以下に記名された発明者として、ここに下記の通り宣言する：

As a below names inventor, I hereby declare that:

私の住所、郵便の宛先そして国籍は、私の氏名の後に記載された通りである。

My residence, post office address and citizenship are as stated next to my name:

I believe I am the original, first and sole inventor if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled.

ENCODING SYSTEM AND METHOD, DECODING  
SYSTEM AND METHOD, MULTIPLEXING APPARATUS  
AND METHOD, AND DISPLAY SYSTEM AND METHOD

the specification of which is attached hereto unless the following box is checked:

☒ was filed on 4 February 2000  
as United States Application Number of  
PCT International Application Number PCT/JP00/00629  
\_\_\_\_\_ and was amended on  
\_\_\_\_\_ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

上記発明の明細書はここに添付されているが、下記の欄がチェックされている場合は、この限りでない：

☐ \_\_\_\_\_ の日に出願され、  
この出願の米国出願番号またはPCT国際出願番号は、  
\_\_\_\_\_ であり、且つ  
\_\_\_\_\_ の日に補正された出願（該当する場合）

私は、上記の補正書によって補正された、特許請求範囲を含む上記明細書を検討し、且つ内容を理解していることをここに表明する。

私は、連邦規則法典第37編規則1.56に定義されている、特許性について重要な情報を開示する義務があることを認める。

Burden Hour Statement: This form is estimated to take 0.4 hours to complete. Time will vary depending upon the need of the individual case. Any comments on the amount of time you are required to complete this form should be sent to Chief Information Officer, U.S. Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner of Patents and Trademarks, Washington, DC 20231.

## Japanese Language Declaration

## 日本語宣言書

私は、ここに、以下に記載した外国での特許出願または発明者証の出願、或いは米国以外の少なくとも一國を指定している米国法典第35編第365条(a)によるPCT国際出願について、同第119条(a)-(d)項又は第365条(b)項に基づいて優先権を主張するとともに、優先権を主張する本出願の出願日より前の出願日を有する外国での特許出願または発明者証の出願、或いはPCT国際出願については、いかなる出願も、下記の枠内をチェックすることにより示した。

## Prior Foreign Application(s)

## 外国での先行出願

11-029375  
(Number)  
(番号)

Japan  
(Country)  
(国名)

11-029376  
(Number)  
(番号)

Japan  
(Country)  
(国名)

11-029377  
(Number)  
(番号)

Japan  
(Country)  
(国名)

PCT/JP00/00629  
(Number)  
(番号)

PCT  
(Country)  
(国名)

(Number)  
(番号)

(Country)  
(国名)

(Number)  
(番号)

(Country)  
(国名)

私は、ここに、下記のいかなる米国仮特許出願についても、その米国法典第35編第119条(e)項の利益を主張する。

(Application No.)  
(出願番号)

(Filing Date)  
(出願日)

私は、ここに、下記のいかなる米国出願についても、その米国法典第35編第120条に基づく利益を主張し、又米國を指定するいかなるPCT国際出願についても、その同第365条(c)に基づく利益を主張する。また、本出願の各特許請求の範囲の主題が、米国法典第35編第112条第1段に規定された態様で、先行する米国出願又はPCT国際出願に開示されていない場合においては、その先行出願の出願日と本国内出願日またはPCT国際出願日との間の期間中に入手された情報で、連邦規則法典第37編規則1.56に定義された特許性に関わる重要な情報について開示義務があることを承認する。

(Application No.)  
(出願番号)

(Filing Date)  
(出願日)

私は、ここに表明された私自身の知識に係わる陳述が真実であり、且つ情報と信ずることに基づく陳述が、真実であると信じられることを宣言し、さらに、故意に虚偽の陳述などを行った場合は、米国法典第18編第1001条に基づき、罰金または拘禁、若しくはその両方により処罰され、またそのような故意による虚偽の陳述は、本出願またはそれに対して発行されるいかなる特許も、その有効性に問題が生ずることを理解した上で陳述が行われたことを、ここに宣言する。

I hereby claim foreign priority under Title 35, United States Code, Section 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International application which designated at least one country other than the United States listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT international application having a filing date before that of the application for which priority is claimed.

## Priority Not Claimed

## 優先権主張なし

5 February 1999  
(Day/Month/Year Filed)

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5 February 1999  
(Day/Month/Year Filed)

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5 February 1999  
(Day/Month/Year Filed)

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4 February 2000  
(Day/Month/Year Filed)

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(Day/Month/Year Filed)

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(Day/Month/Year Filed)

☐

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.)  
(出願番号)

(Filing Date)  
(出願日)

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365(c) of any PCT international application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of application.

(Status: Patented, Pending, Abandoned)  
(現況: 特許許可、係属中、放棄)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Japanese Language Declaration

日本語宣言書

委任状: 私は本出願を審査する手続を行い、且つ米国特許商標庁との全ての業務を遂行するために、記名された発明者として、下記の弁護士及び/または弁理士を任命する。(氏名及び登録番号を記載すること)

書類送付先

直通電話連絡先: (氏名及び電話番号)

**POWER OF ATTORNEY:** As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith (list name and registration number)

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